DRAINAGE REPORT

RUTHIES

TOWN OF NEW WINDSOR
ORANGE COUNTY, NEW YORK

ENGINEERING REPORT

FINE & ASSOCIATES
152 MAIN STREET
GOSHEN, NEW YORK 10924

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NY. Lic. #

11/4/08

October 23, 2008

TABLE OF CONTENTS

INTRODUCTION

This report will cover the storm water flows for the undeveloped and developed condition for Ruthies, located on the northwesterly NYS Route 32 and Ruscitti Road in the Town of New Windsor, Orange County, New York. The project is currently identified as Section 10, Block 2, Lot 7 on the Town of New Windsor tax map. Total site area is approximately 1.68 +/- acres. Total approximate of 1.34 +/- acres of the property will be disturbed for contraction of parking, lawns and retaining walls. The remaining acreage has already existing building and paved parking that will be utililized after the construction. This drainage analysis, however, addressed 1.68 acres +/- site in the undeveloped and developed conditions.

EXISTING CONDITIONS:

At the present time the property consists of wooded trees, grass mixture with brush and existing two building with one paved parking. The site soils have been classified in accordance with the Orange County Soil Survey. The approximate percentages of the soils on the site are 100% Hoosic (HoB). Hoosic soil is a hydrological group A.

Most of flow from the project site discharges in to the existing ponding area located in the middle of the property and then overflow to the existing catch basins at Route 32. A drainage Basin Map is included at the back of this report. Subcatchment 1S discharge to the existing ponding area in the middle of the property and then overflow to the existing catch basin at Route 32. Subcatchment 2S discharge directly to the existing catch basin at Route 32.

The underdeveloped flows from this project are included in Appendix A and summarized below based on TR-20 methodology. Reach point 1R (design point) represents the peak flow resulting from the Subcatchments 1S and 2S. The location of the reach point is shown on Pre-development and Post-development plan.

Subcatchment:

	1S	2S	1R
Drainage Area (acres)	1.34	0.410	1.75
Weighted CN Value	54	80	------
Time of Concentration (min)	14.5	14.8	------
Peak flow 1 year storm (cfs)	0.05	0.42	0.42
Peak flow 2 year storm (cfs)	0.17	0.59	0.59
Peak flow 10 year storm (cfs)	1.15	1.21	1.21
Peak flow 100 year storm (cfs)	3.04	2.02	2.02

DEVELOPED CONDITIONS:

Under developed conditions, the site will be consist of a 0.18 acre of roof area (one existing building) and 1.15 acres of paved driveway, parking and sidewalk. The TR-20 calculations for these conditions are included in Appendix B and summarized below for the developed and undeveloped conditions. There will be small impact to drainage pattern. Some of the drainage areas in subcatchment 1S will be directed to the proposed Pond I-2 (Infiltration Basin I-2) and then discharged to the existing catch basin at the south of the main interance driveway.

Subcatchments:

	1S	2S	1R
Drainage Area (acres)	1.43	0.36	1.79
Weighted CN Value	86	84	------
Time of Concentration (min)	3.9	14.8	------
Peak flow 1 year storm (cfs)	2.79	0.46	3.05
Peak flow 2 year storm (cfs)	3.70	0.62	4.07
Peak flow 10 year storm (cfs)	6.83	1.18	7.55
Peak flow 100 year storm (cfs)	10.73	1.90	11.91

Existing Versus Developed Flows

Subcatchments:

	Existing	Developed	Change
Peak flow 1 year storm (cfs)	-0.42	3.05	+2.63
Peak flow 2 year storm (cfs)	-0.59	4.07	+3.48
Peak flow 10 year storm (cfs)	-1.21	7.55	+6.34
Peak flow 100 year storm (cfs)	-2.02	11.91	+9.89

The above calculations show an increase in post development condition. Some of these increase will be handled through the proposed Pond I-2 (Infiltration Basin I-2) to be constructed in the Subcatchment 1S.

IV. STORMMANAGEMENT:

SUBCATCHMENT 1S

The flow from Subcatchment 1S will be directed to Pond I-2 (Infiltration Basin I-2). The TR-20 calculations for the inflow hydrograph to the pond is given in Appendix C and summarized on the following page:

Drainage Area (acre)	1.43
Peak flow 1 year storm (cfs)	2.79
Peak flow 2 year storm (cfs)	3.70
Peak flow 10 year storm (cfs)	6.83
Peak flow 100 year storm (cfs)	10.73

The flow was routed through Pond I-2 (Infiltration Basin I-2). The results of the calculations also included in Appendix C and summarized below:

Pond I-2 (Infiltration Basin I-2)

Storm Event	Max Inflow (cfs)	Max outflow (cfs)	Reduction in flow (cfs)	Max elev. (ft)	Freeboard Top elev. 166 (ft)
1 year	2.79	0.07	-2.72	164.36	1.64
2 Years	3.70	0.27	-3.43	164.40	1.60
10 Years	6.83	4.83	-2	164.73	1.27
100 Years	10.73	9.78	-0.95	164.96	1.04

DESIGN POINTS (REACH POINTS 1R)

Design points 1R for the analysis were selected at downstream. See the drainage maps for location. The TR-20 calculations for the inflow hydrograph for the predeveloped and postdeveloped condition for these points are given in the Appendices and summarized on the following page.

Subcatchments:

	Pre-developed Peak flow (cfs) Reach Point 1R	Post-developed Peak flow (cfs) Reach Point 1R	Change
Peak flow 1 year storm (cfs)	0.42	0.46	0.04
Peak flow 2 year storm (cfs)	0.59	0.62	0.03
Peak flow 10 year storm (cfs)	1.21	5.92	+4.71
Peak flow 100 year storm (cfs)	2.02	11.23	+9.21

*See Reach Point 1R in the appendix C

Pond I-2 (Infiltration Basin I-2) has effectively controled post-developed peak flow for the 1 and 2 year storm to close to the pre-developed peak flow of the 1 and 2 year storm. In conclusion, this project will produce close to zero net increases in the runoff of 1 and 2 year storm and no adverse impact to the downstream areas for 1 and 2 year storm. However, the 10 and 100 year storm can not be controled due to the limited of space, therefore further analysis will be needed to study the affect of this increase to the existing down stream areas and drainage structures.

V. WATER QUALITY MANAGEMENT:

The water quality will be handled through the Infiltration Basin (I-2) and is based on the 1.2 inch of rain over the impervious area in Subcatment 1S.

The existing impervious area in the Subcatchment 2S will not be provided the water quility treatiment since it is existing.

Total impervious Area in Subcatchment 1S = 1.07 acre
Total Area Subcatchment 1S = 1.43 acre

Impervious Coverage (I) = 74.83 %

Runoff coefficient (Rv) = 0.72

WQv = 4,506 cf

24 hours release rate = 0.05 cfs

This volume will be contained in the lower level of Infiltration Basin (I-2). Based on the Orange County Soil Survey, the existing soil for the entire site is Hoosic (HoB). Hoosic soil is a hydrological group A, has an infiltration rate less 0.5 inch per hour and ground water elevation bellow 6 ft. Therefore, the location of the proposed Infiltration Basin meets the requirements of New York State Storm Management Design Manual.

In addition, the upper level of the proposed Infiltration Basin will provide stream channel protection water quantity volume. The entire one year storm from Subcatchment 1S will be captured and released slowly within 24 hrs per New York State Storm Management Design Manual. The support calculations are included in appendix D and C (one year storm)

VI. Storm Water Infrastructure Maintenance:

Long term maintenance of all drainage structures, pipes, and treatment devices will be the responsibility of the owner.

Long term maintenance shall include the following:

Inspection:

The drainage infrastructure should also be inspected after major storm events to ensure that the outlet orifices and inlets remain open. Particular attention should be given to:

- Evidence of clogging
- Erosion of the flow path

- Condition of the embankments
- Condition of the spillways
- Accumulation of sediment at the outlets and sumps
- Erosion of riprap aprons
- Sources of erosion in the contributory drainage which should be stabilized.

Debris and Litter Control:

Removal of debris and litter should be accomplished during mowing operations. Particular attention should be given to removing debris and trash around outlets to prevent clogging.

Erosion Control:

Eroding soils in drainage areas should be stabilized immediately with vegetative practices or other erosion control practices. Potential problems are erosion that may occur on the embankment, slopes, and spillways. Also, attention should be given to repositioning protective riprap where appropriate.

Sediment Removal:

Sediment should be removed periodically in order to preserve the available storm water treatment capacity of the infiltration devices, and to prevent outlets or filtering mediums from becoming clogged. Also, unless removed, accumulated sediment may become unsightly. While more frequent clean-out may be needed around outlets, a typical clean-out cycle for the entire storm water infrastructure should range from 5 to 10 years.

VII. Erosion and Sediment Control:

Erosion and sediment control measures are to be incorporated into the project construction. These practices have been developed in accordance with those set forth in the New York State Department of Environmental Conservation publication entitled "Stormwater Management Design Manual".

Erosion Control Measures:

The following erosion control measures will be incorporated to minimize erosion potential:

- Filter fabric silt fence:

  Silt fence shall be used to control erosion from sheet flow on slopes not to exceed two horizontal to one vertical. Concentrated flows shall not be directed toward silt fence and spacing shall vary from 50' to 200' depending on slope steepness.

Permanent and temporary seeding mixtures:

Permanent and temporary seeding, mulch, fertilizer, soil amendments, and slope stabilization will be used on seeded areas. Land that is stripped of vegetation will be left bare for the shortest time possible. Any area that will remain cleared, but not under construction for 20 days or longer, will be seeded with a temporary mixture. Topsoil shall be stockpiled, stabilized with temporary seeding, and saved for reuse on the site.

- Slope Stabilization:

  All slopes shall be stabilized to minimize erosion. Slopes shall be stabilized with temporary seeding mixtures and straw mulch. Slopes in excess of four horizontal to one vertical shall be stabilized with jute netting and hydro-seed. Existing vegetation, which is not to be removed, will also act as filter strips to protect down-slope areas. Runoff will be diverted from newly graded areas to prevent erosion until a permanent ground cover has been established.

- Dust Control:

  Measures for dust control during construction shall be implemented as needed (daily water sprays will be used during dry conditions and Calcium Chloride will be used only if necessary), in addition to water sprays, temporary plantings will aid in minimizing dust.

- Temporary Diversion Swales:

  Temporary diversion swales shall be constructed to either divert clean storm water runoff from newly graded areas or direct sediment laden runoff to a sediment trapping device.

- Channel Stabilization:

  Drainage channels and temporary diversion swales shall be stabilized with seed, jute netting or riprap, as specified, to minimize deterioration of the channel bed.

- Sediment Traps:

  Sediment traps shall be constructed in the location, and be of size and type specified to collect sediment from sediment laden storm water runoff. Sediment traps shall be constructed downstream of disturbed areas and be in place prior to disturbance within the contributory area.

- Stabilized Construction Entrance:

Route 32 will be protected by installation of crushed stone blanket for cleaning construction vehicle wheels. Blankets shall be placed at the intersection of the construction driveway with the Route 32. Stabilized construction entrances shall be installed in the location shown on the drawing and be of size and type specified.

- Tree Protection:

  Trees to be preserved within areas of construction shall be protected. In areas of concentrated construction activity temporary fencing will be placed around the driplines. In all other areas, construction workers will be directed to avoid the storing of equipment or soil under trees to be preserved, in order to prevent soil compaction. If necessary, trees will be preserved with tree wells in fill areas, and retaining walls in cut areas.

- Erosion Control Sequence

  Prior to any site disturbance, the developer should thoroughly review and familiarize the approved erosion control plan. The installation of erosion control measures should begin with the most downstream device, then working upstream. When installing erosion control measures, the sequence should generally be as follows:

  - Prior to commencing construction activities, the limits of clearing and grading shall be clearly marked. Perimeter silt fence and stabilized construction entrances shall be put in place.
  - Upon completion of clearing and grubbing activities, topsoil shall be stripped from all areas to be disturbed and stockpiled. Stockpiled topsoil shall be stabilized by temporary seeding and surrounded with a perimeter silt fence
  - Temporary erosion control devices shall be installed prior to commencing earth moving activities. This includes the installation of sediment traps, diversion swales, and check dams beginning at the most downstream portions of the site and then working upstream.
  - Immediately after completion of rough grading, remaining temporary erosion control shall be installed as specified, including additional silt fence, diversion swales, and check dams. Any areas not requiring further earth work shall be fine graded topsoiled and stabilized as early as possible.

- Maintenance of Erosion Control Devices

  The maintenance of erosion control devices will be the responsibility of the Site Developer. A critical part of an effective erosion control plan is a conscientious maintenance program. All erosion control devices will be cleaned and restored

throughout construction to maintain their effectiveness. The Job Superintendent will monitor the condition of all devices and clean or replace them as conditions require. All erosion control devices shall be installed and maintained in accordance with the approved plans, manufacturer's recommendations, and as directed by Town representatives including the Town engineer and building inspector.

Specific maintenance shall include:

- Maintaining seeded areas including reseeding weak areas, regrading wash outs and fertilizing.
- Maintaining mulched areas including replacement of disturbed mulched areas.
- All devices shall be inspected after each rain and repaired as needed.
- Sediment shall be removed from behind silt fence when bulges start to occur and fencing reset to original condition.
- Outlets in sediment basins shall be free of silt and debris by hand raking and cleaning after each rain storm.
- Construction equipment shall not unnecessarily cross drainage swales. Crossing of drainage channels shall be by means of bridges, culverts or other approved methods.
- Culverts shall be maintained free of silt or debris.
- Tree protection fencing to be inspected daily during grading and finish grading operations.
- Daily water sprays will be used as needed or as directed by the Consulting Engineer or Town representatives. Water sprays will be used to prevent pollution from dust until construction is completed and soil cover is established.

- Removal of Erosion Control Devices:

No erosion control structures shall be removed until all work upstream has been completed, stabilized, and approved by the Consulting Engineer and Town Representatives.

The removal of erosion control devices should generally be as follows:

- After construction, the temporary erosion control structures are to be removed in reverse order with the most upstream structure removed first and thence proceeding downstream.

- All silt fences shall be removed and properly disposed of off-site.

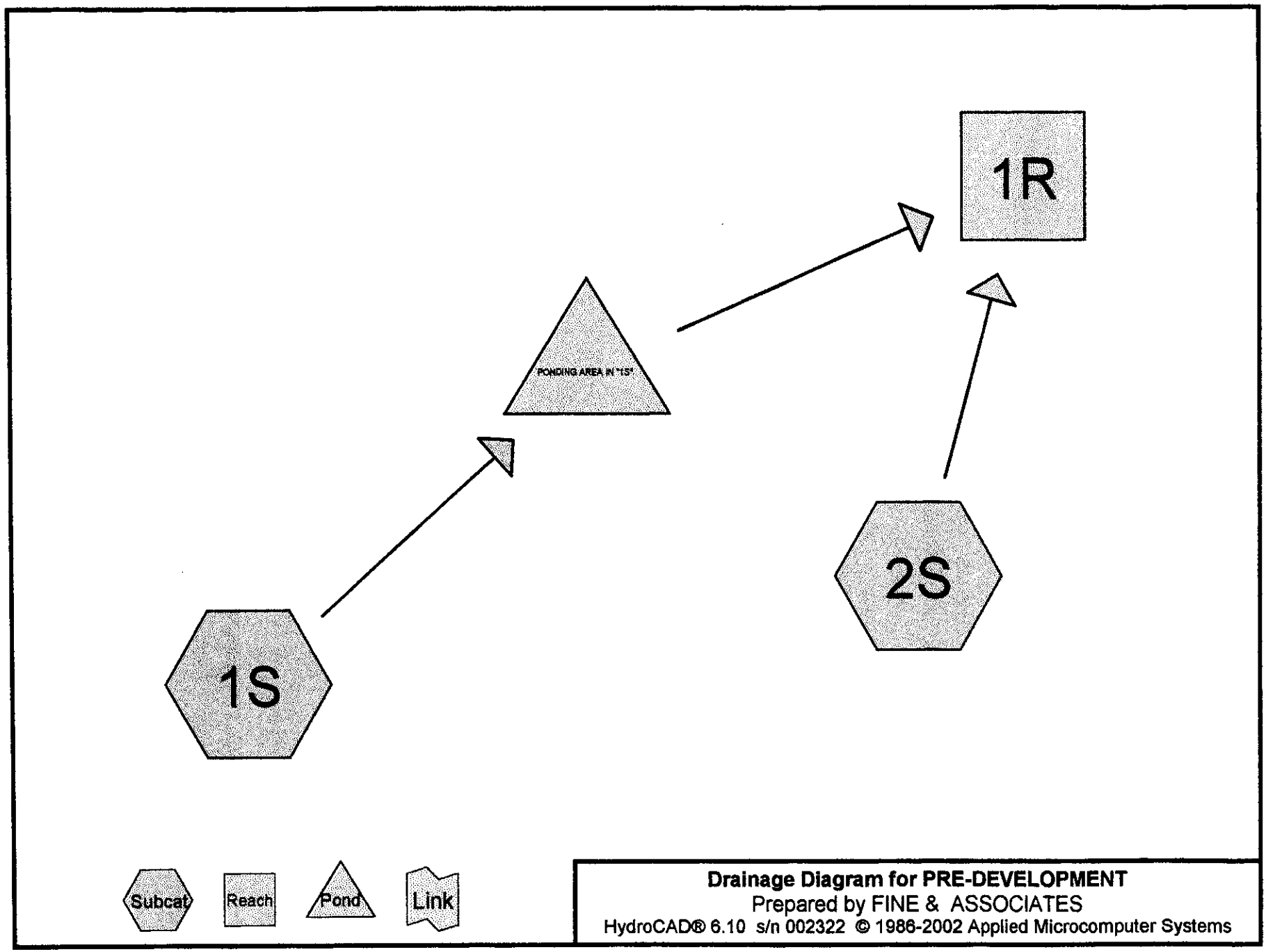
- All tree protection fencing shall be removed after adjacent areas have been graded, topsoiled, seeded, and vegetation has been established.

- All temporary construction culverts shall be removed and areas graded, topsoiled, and seeded.

- Any washouts shall be re-topsoiled and seeded.

APPENDIX A

HYDROCAD PRE-DEVELOPED CALCULATIONS



Drainage Diagram for PRE-DEVELOPMENT
Prepared by FINE & ASSOCIATES

Subcatchment 1S:

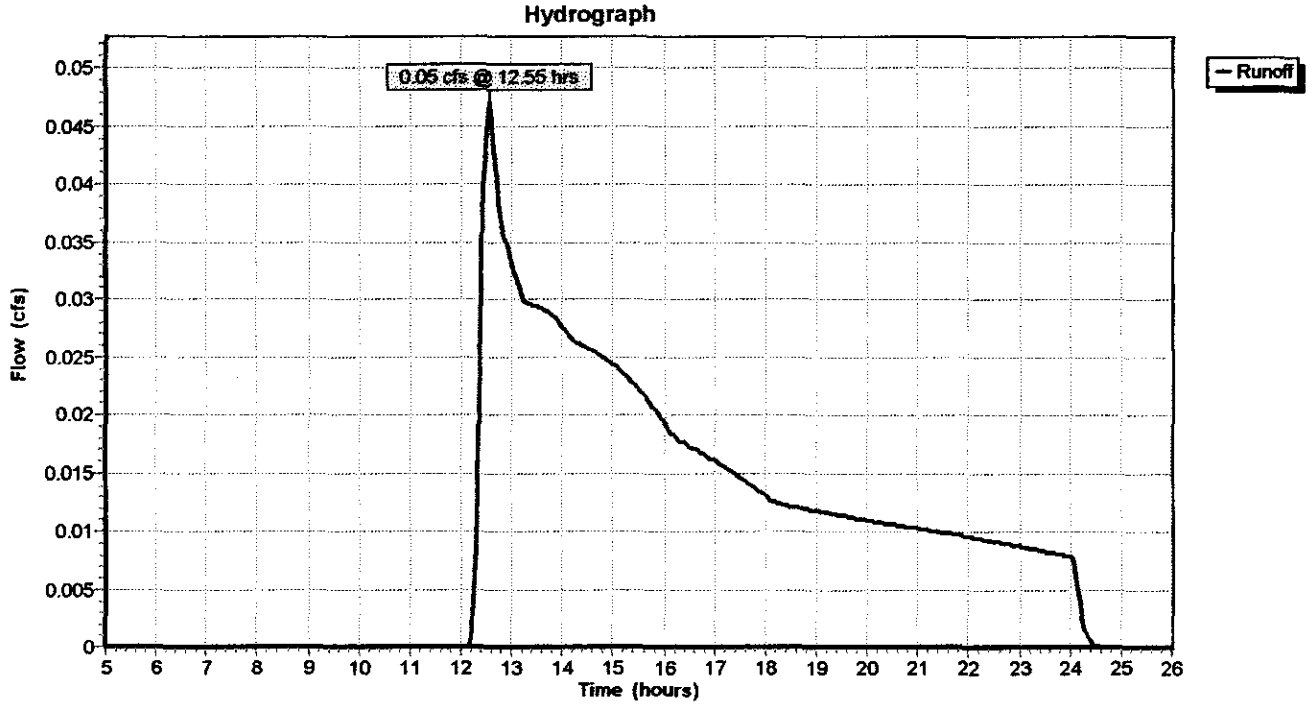
Runoff = 0.05 cfs @ 12.55 hrs, Volume= 0.016 af, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.170	98	Paved
0.100	98	roofs
0.500	36	Woods, Fair, HSG A
0.570	49	50-75% Grass cover, Fair, HSG A
1.340	54	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	114	0.1200	0.2		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50"
3.0	38	0.0500	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	52	0.0770	1.9		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.5	204	Total			

Subcatchment 1S:



Subcatchment 2S:

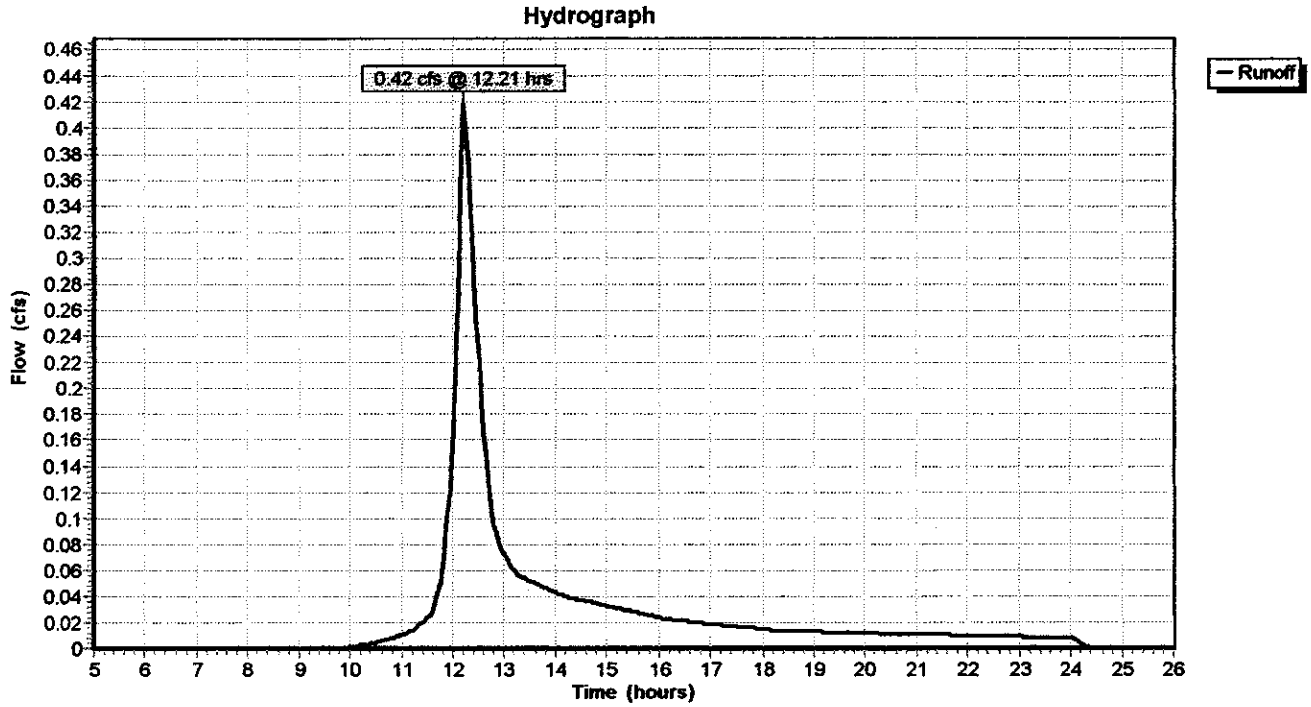
Runoff = 0.42 cfs @ 12.21 hrs, Volume= 0.040 af, Depth= 1.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.150	49	50-75% Grass cover, Fair, HSG A
0.410	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

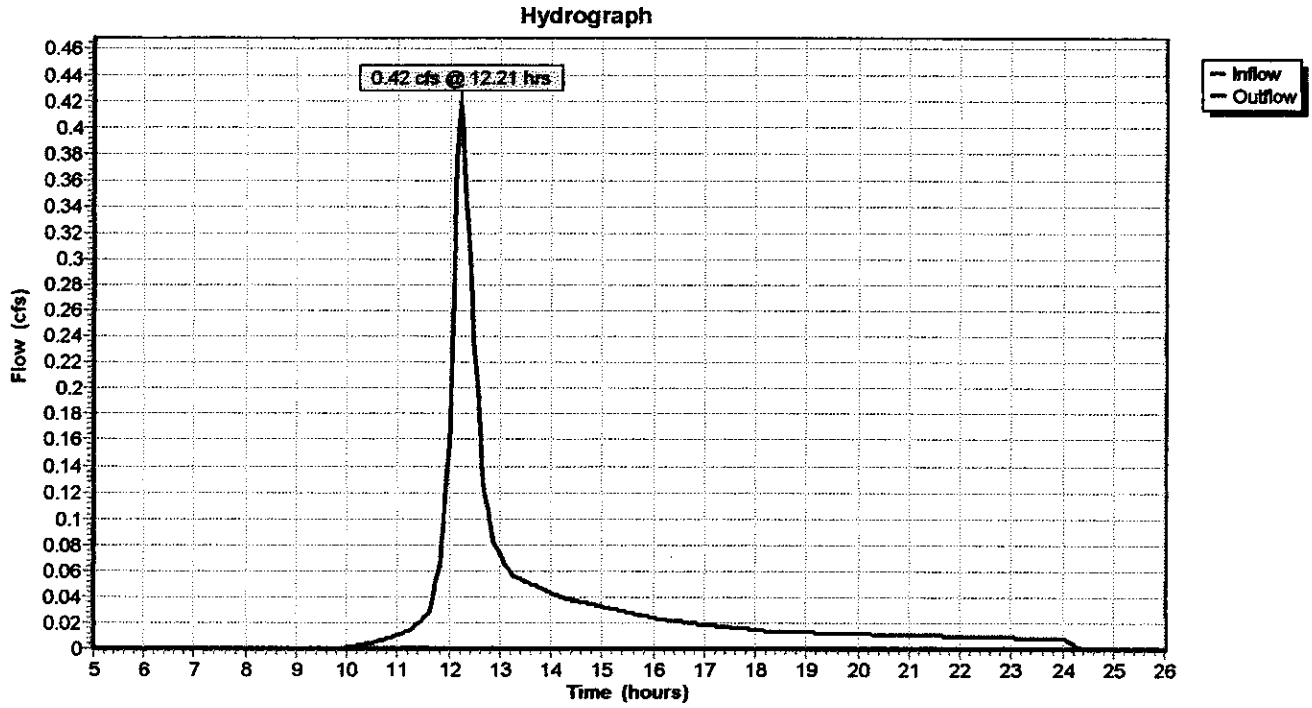


Reach 1R: EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.750 ac, Inflow Depth = 0.28"
Inflow = 0.42 cfs @ 12.21 hrs, Volume= 0.040 af
Outflow = 0.42 cfs @ 12.21 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R: EXISTING CATCH BASIN AT ROUTE 32



Pond PONDING AREA IN "1S":

Inflow Area = 1.340 ac, Inflow Depth = 0.15"
Inflow = 0.05 cfs @ 12.55 hrs, Volume= 0.016 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Discarded = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

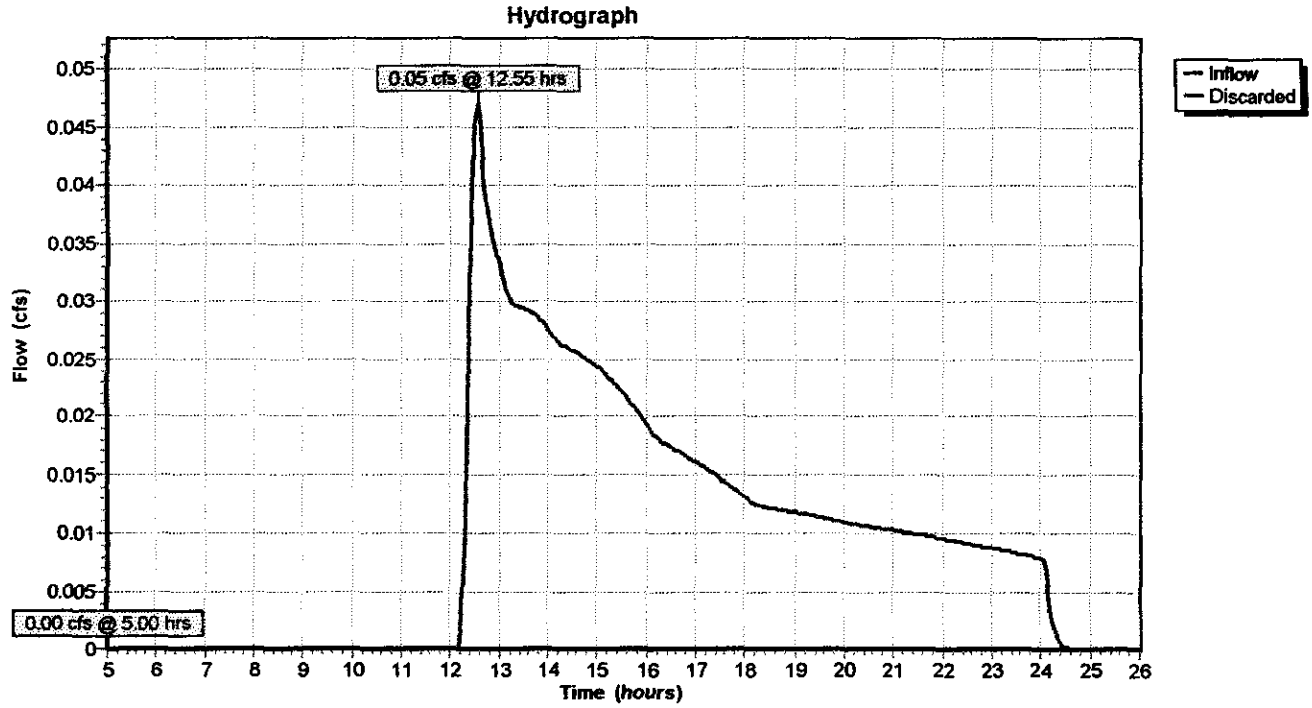
Peak Elev= 163.21' Surf.Area= 1,655 sf Storage= 717 cf
Plug-Flow detention time= (not calculated)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
163.00	380	0	0
164.00	6,500	3,440	3,440
165.00	9,880	8,190	11,630

Discarded OutFlow Max=0.00 cfs @ 5.00 hrs HW=163.00' (Free Discharge)
1=Sharp-Crested Rectangular Weir (swale) (Controls 0.00 cfs)

#	Routing	Invert	Outlet Devices
1	Discarded	164.50'	**13.0' long x 1.0' high Sharp-Crested Rectangular Weir (swale)** 2 End Contraction(s)

Pond PONDING AREA IN "1S":



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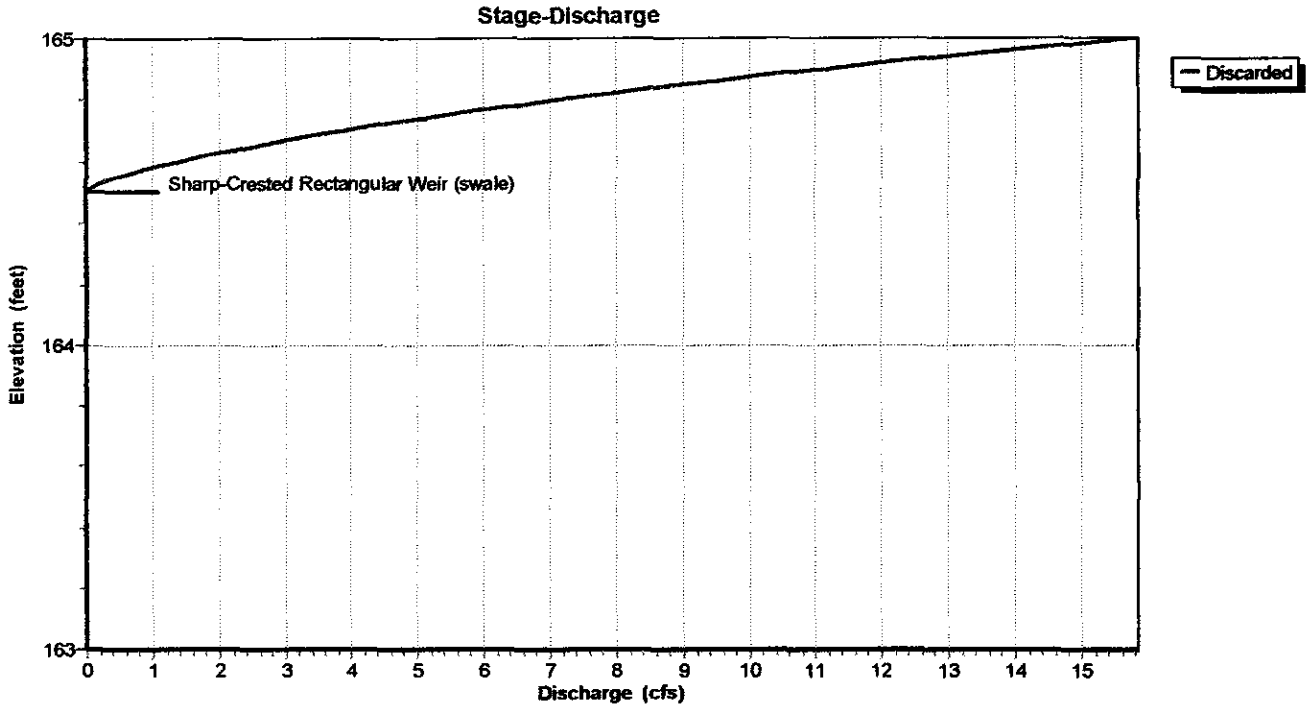

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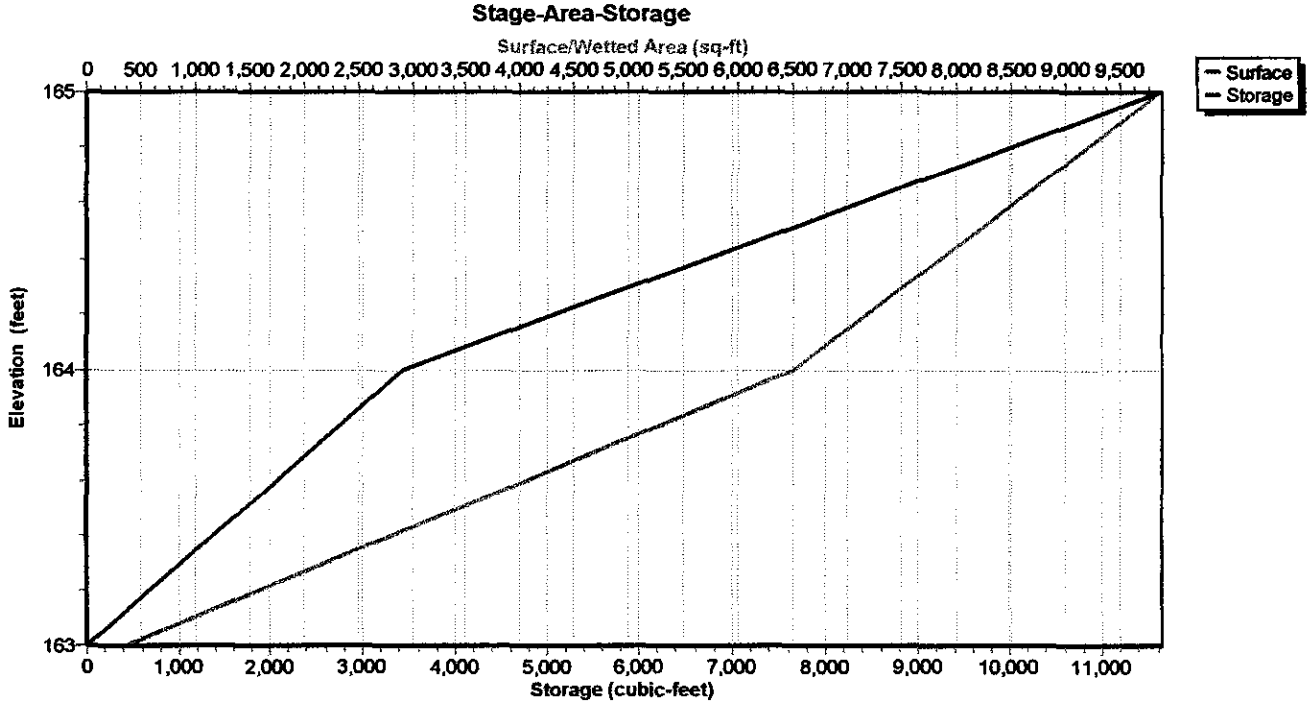


Subcatchment 1S:

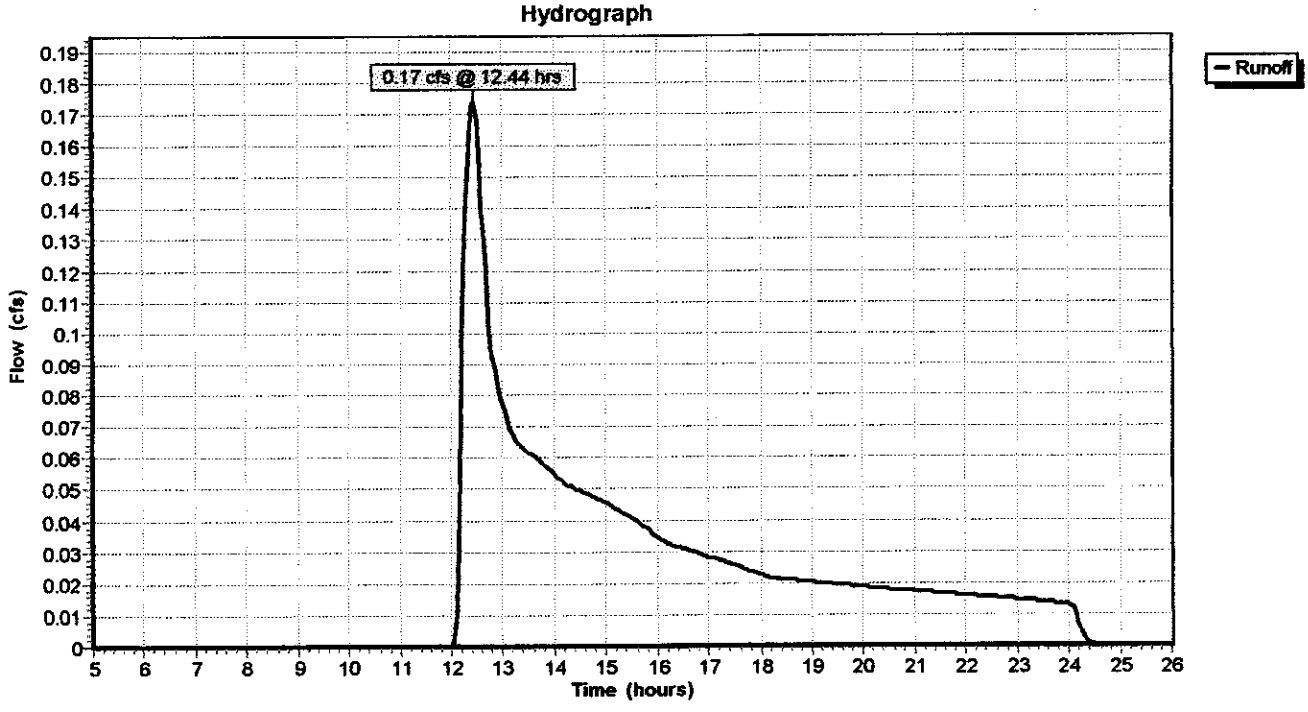
Runoff = 0.17 cfs @ 12.44 hrs, Volume= 0.035 af, Depth= 0.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.50"

Area (ac)	CN	Description
0.170	98	Paved
0.100	98	roofs
0.500	36	Woods, Fair, HSG A
0.570	49	50-75% Grass cover, Fair, HSG A
1.340	54	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	114	0.1200	0.2		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50"
3.0	38	0.0500	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	52	0.0770	1.9		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.5	204	Total			

Subcatchment 1S:



Subcatchment 2S:

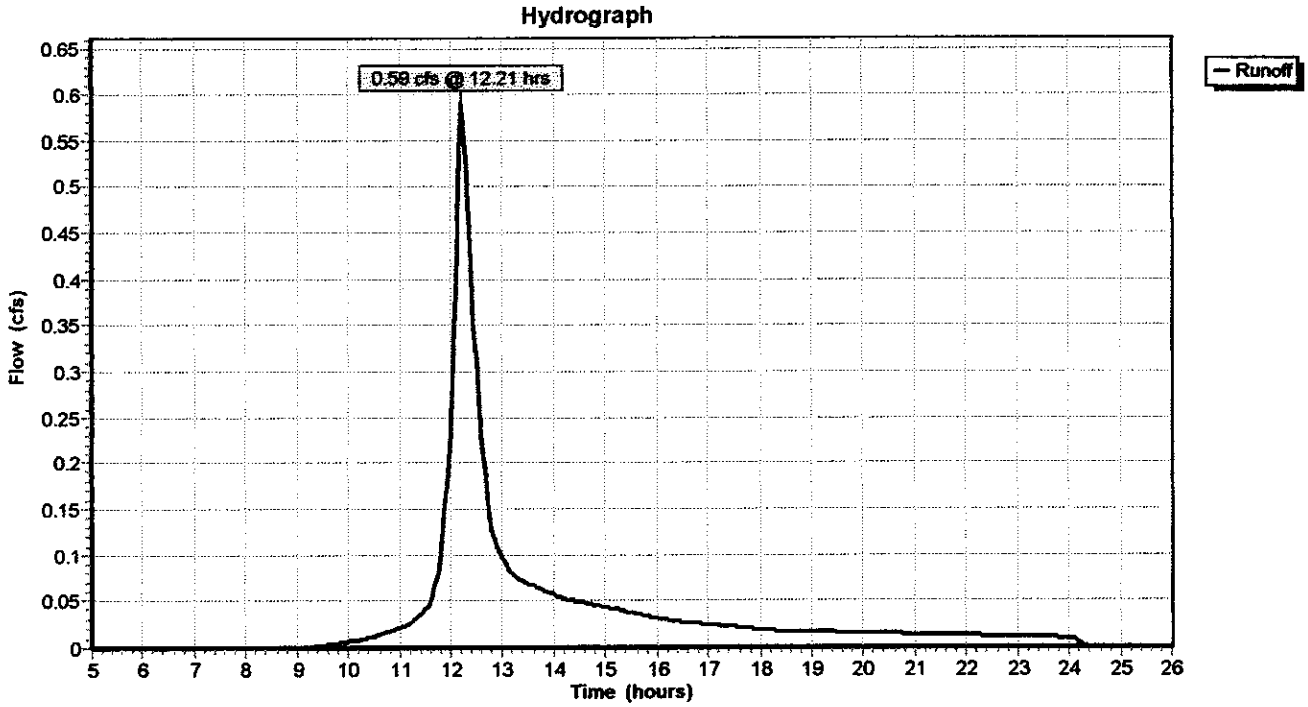
Runoff = 0.59 cfs @ 12.21 hrs, Volume= 0.056 af, Depth= 1.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.50"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.150	49	50-75% Grass cover, Fair, HSG A
0.410	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

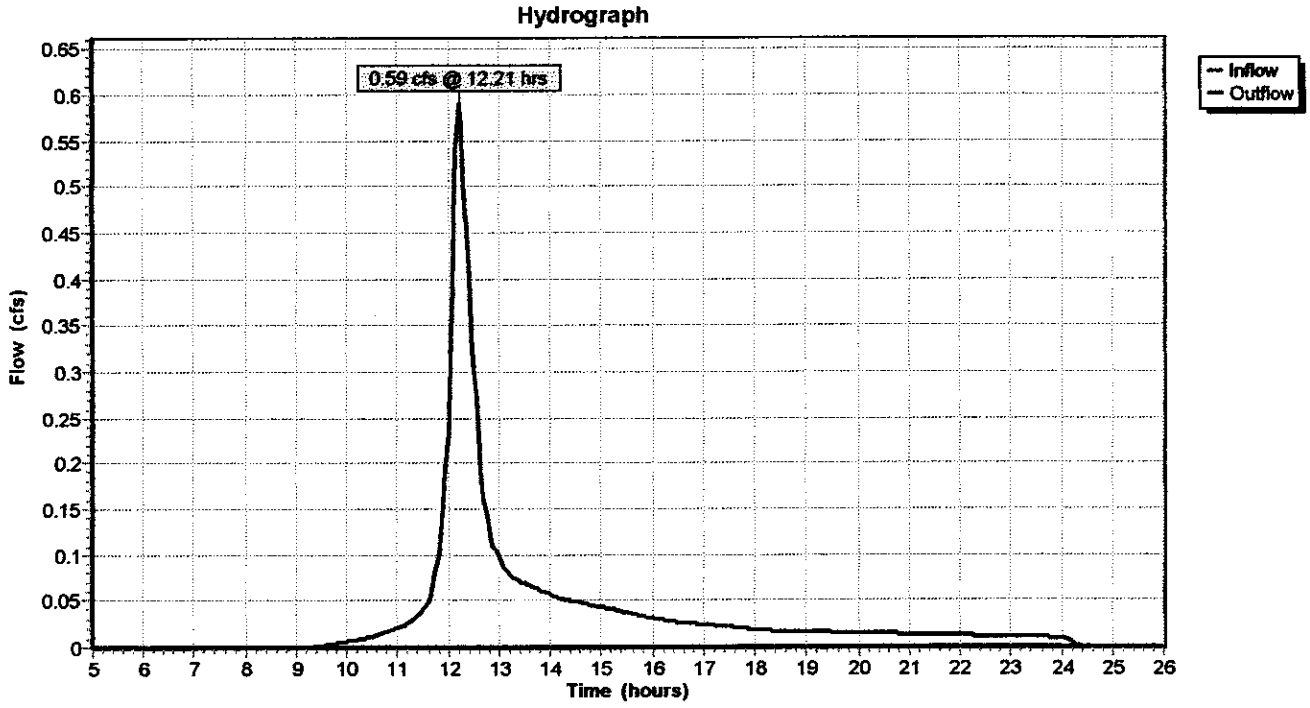


Reach 1R: EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.750 ac, Inflow Depth = 0.38"
Inflow = 0.59 cfs @ 12.21 hrs, Volume= 0.056 af
Outflow = 0.59 cfs @ 12.21 hrs, Volume= 0.056 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R: EXISTING CATCH BASIN AT ROUTE 32



Pond PONDING AREA IN "1S":

Inflow Area = 1.340 ac, Inflow Depth = 0.31"
Inflow = 0.17 cfs @ 12.44 hrs, Volume= 0.035 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Discarded = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

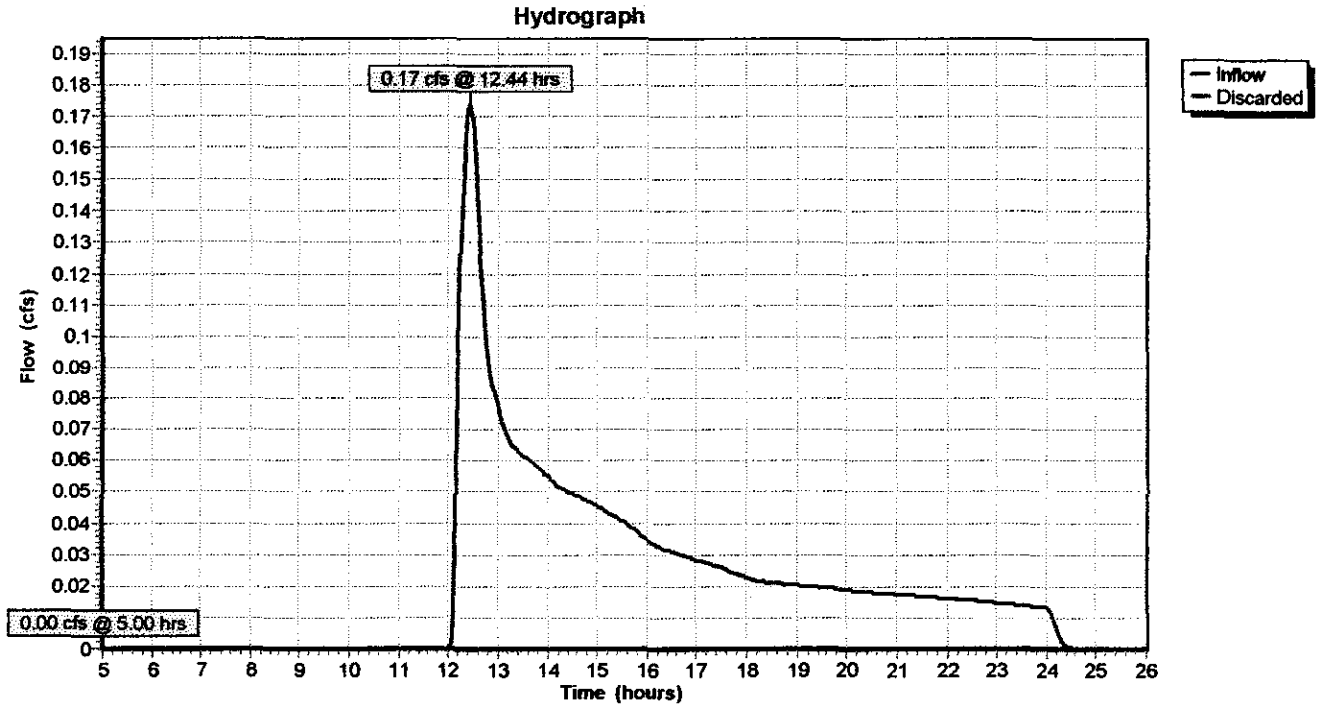
Peak Elev= 163.44' Surf.Area= 3,087 sf Storage= 1,522 cf
Plug-Flow detention time= (not calculated)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
163.00	380	0	0
164.00	6,500	3,440	3,440
165.00	9,880	8,190	11,630

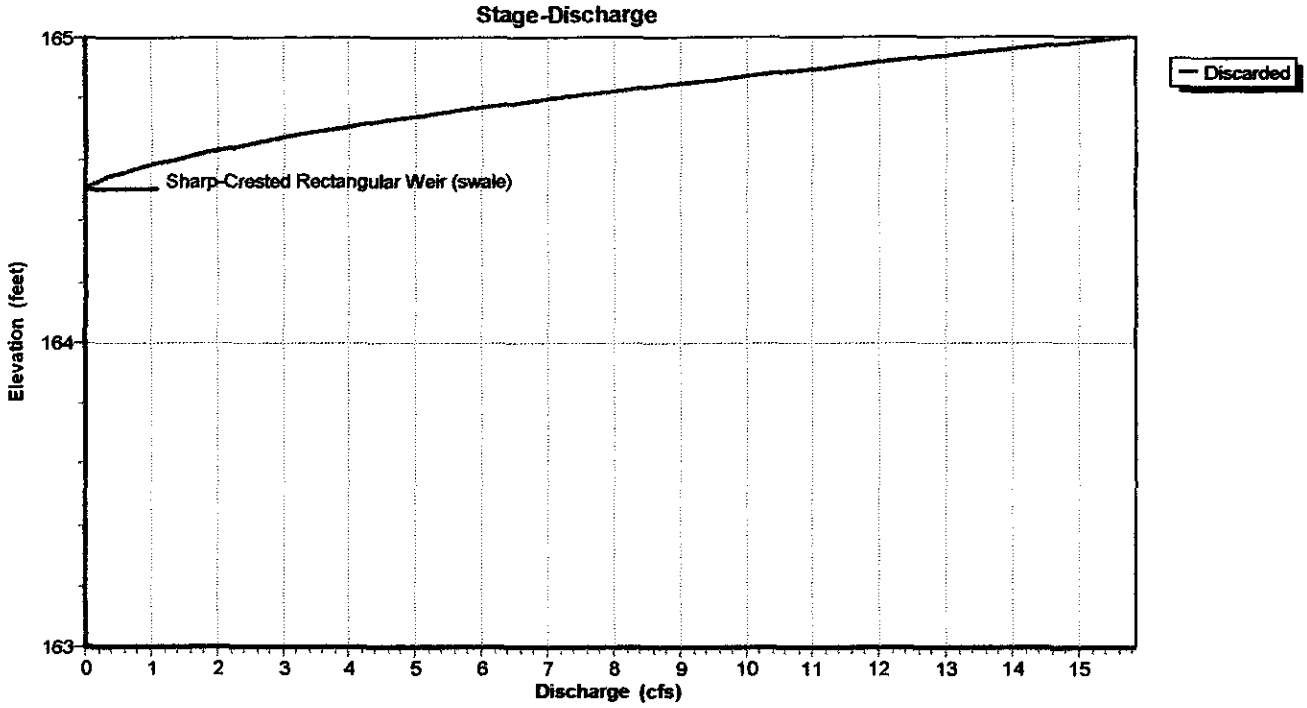
Discarded OutFlow Max=0.00 cfs @ 5.00 hrs HW=163.00' (Free Discharge)
1=Sharp-Crested Rectangular Weir (swale) (Controls 0.00 cfs)

#	Routing	Invert	Outlet Devices
1	Discarded	164.50'	**13.0' long x 1.0' high Sharp-Crested Rectangular Weir (swale)** 2 End Contraction(s)

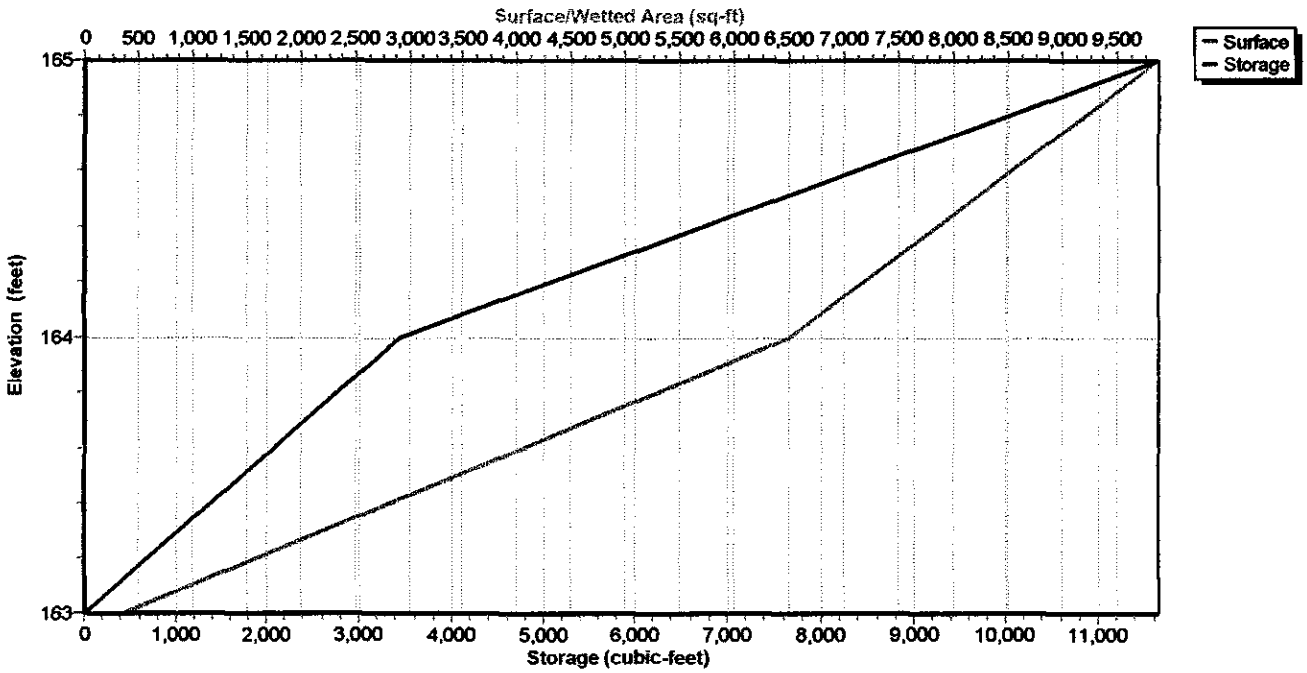
Pond PONDING AREA IN "1S":



Pond PONDING AREA IN "1S":



Pond PONDING AREA IN "1S":



Subcatchment 1S:

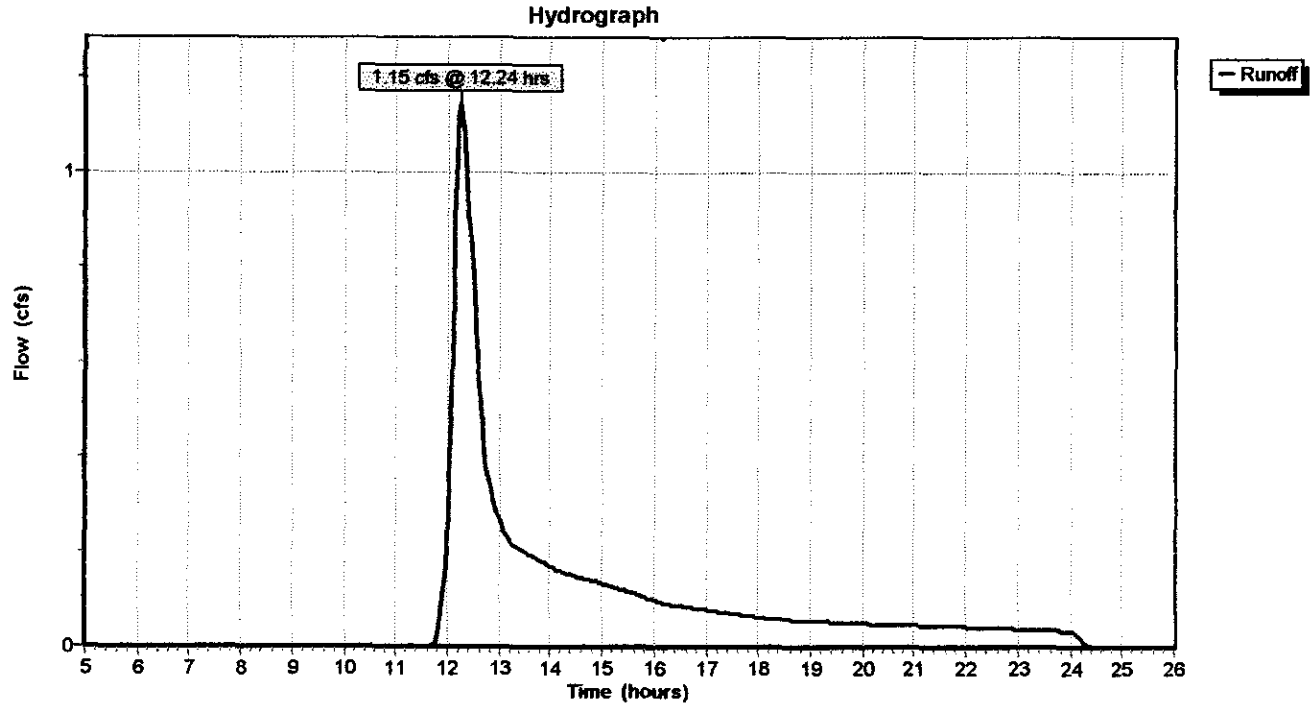
Runoff = 1.15 cfs @ 12.24 hrs, Volume= 0.131 af, Depth= 1.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.50"

Area (ac)	CN	Description
0.170	98	Paved
0.100	98	roofs
0.500	36	Woods, Fair, HSG A
0.570	49	50-75% Grass cover, Fair, HSG A
1.340	54	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	114	0.1200	0.2		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50"
3.0	38	0.0500	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	52	0.0770	1.9		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.5	204	Total			

Subcatchment 1S:



Subcatchment 2S:

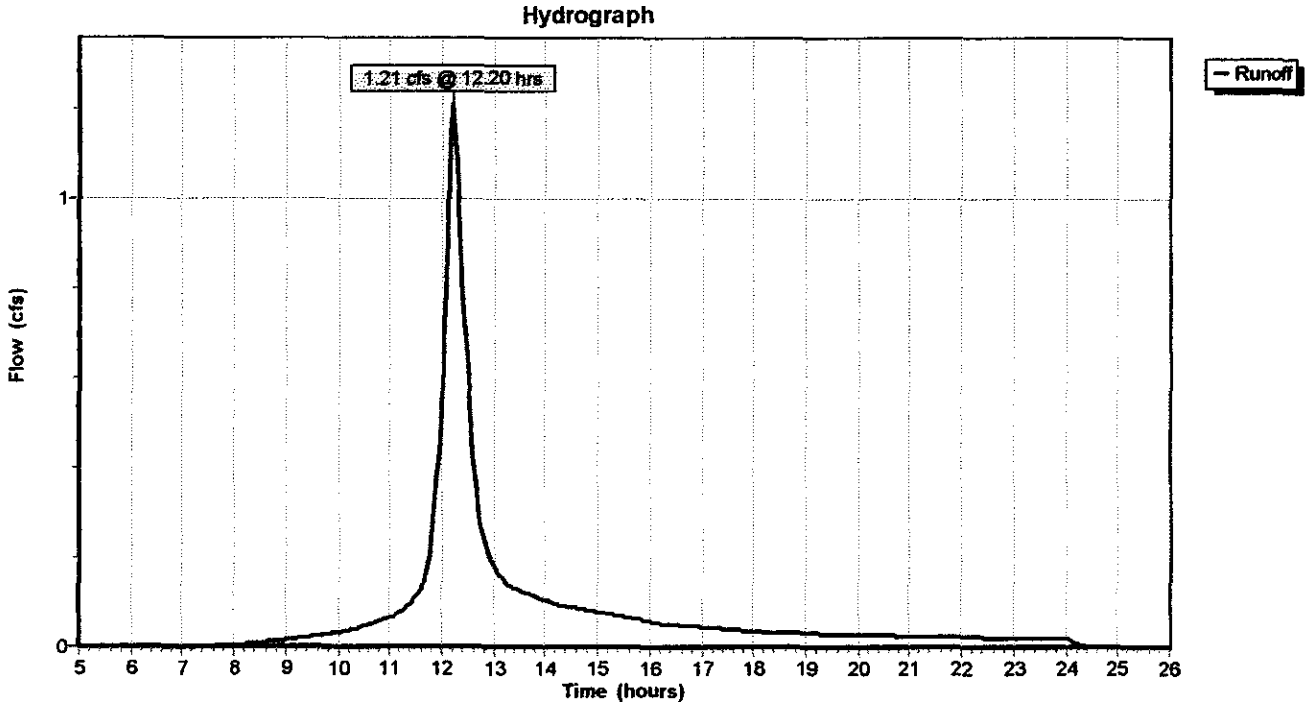
Runoff = 1.21 cfs @ 12.20 hrs, Volume= 0.114 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.50"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.150	49	50-75% Grass cover, Fair, HSG A
0.410	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

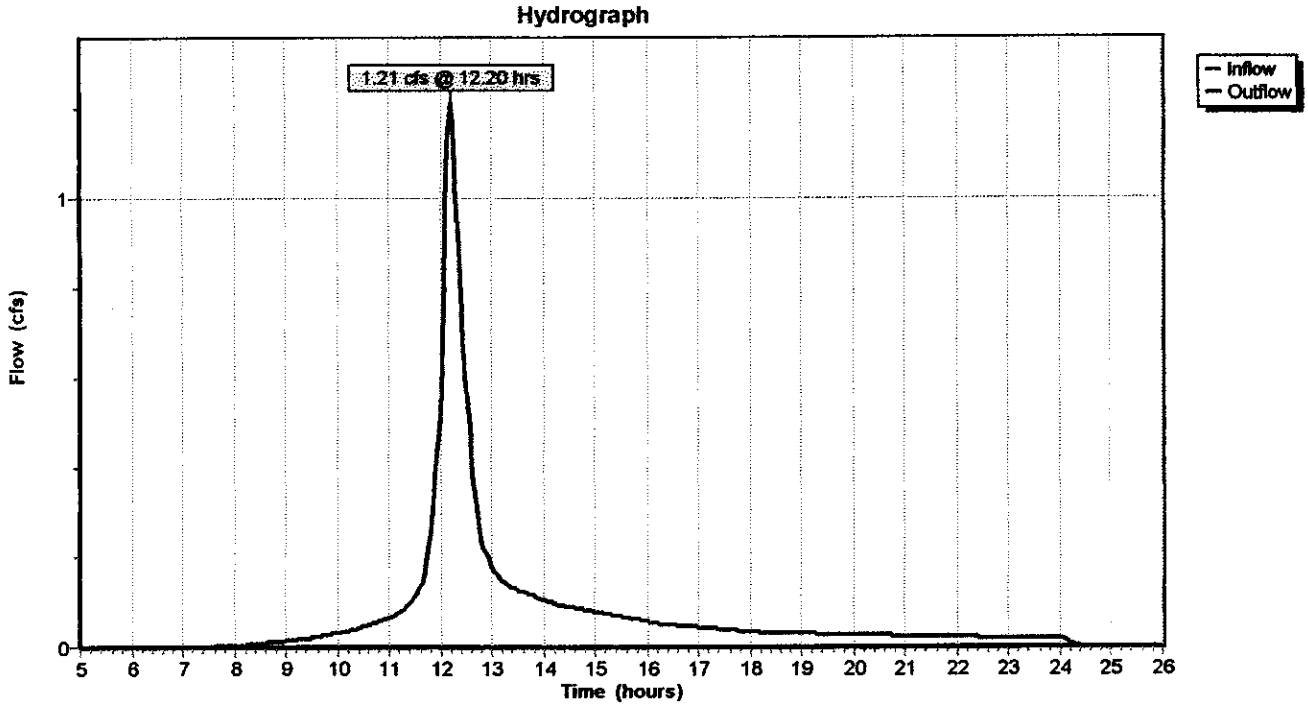


Reach 1R: EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.750 ac, Inflow Depth = 0.78"
Inflow = 1.21 cfs @ 12.20 hrs, Volume= 0.114 af
Outflow = 1.21 cfs @ 12.20 hrs, Volume= 0.114 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R: EXISTING CATCH BASIN AT ROUTE 32



Pond PONDING AREA IN "1S":

Inflow Area = 1.340 ac, Inflow Depth = 1.17"
Inflow = 1.15 cfs @ 12.24 hrs, Volume= 0.131 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Discarded = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

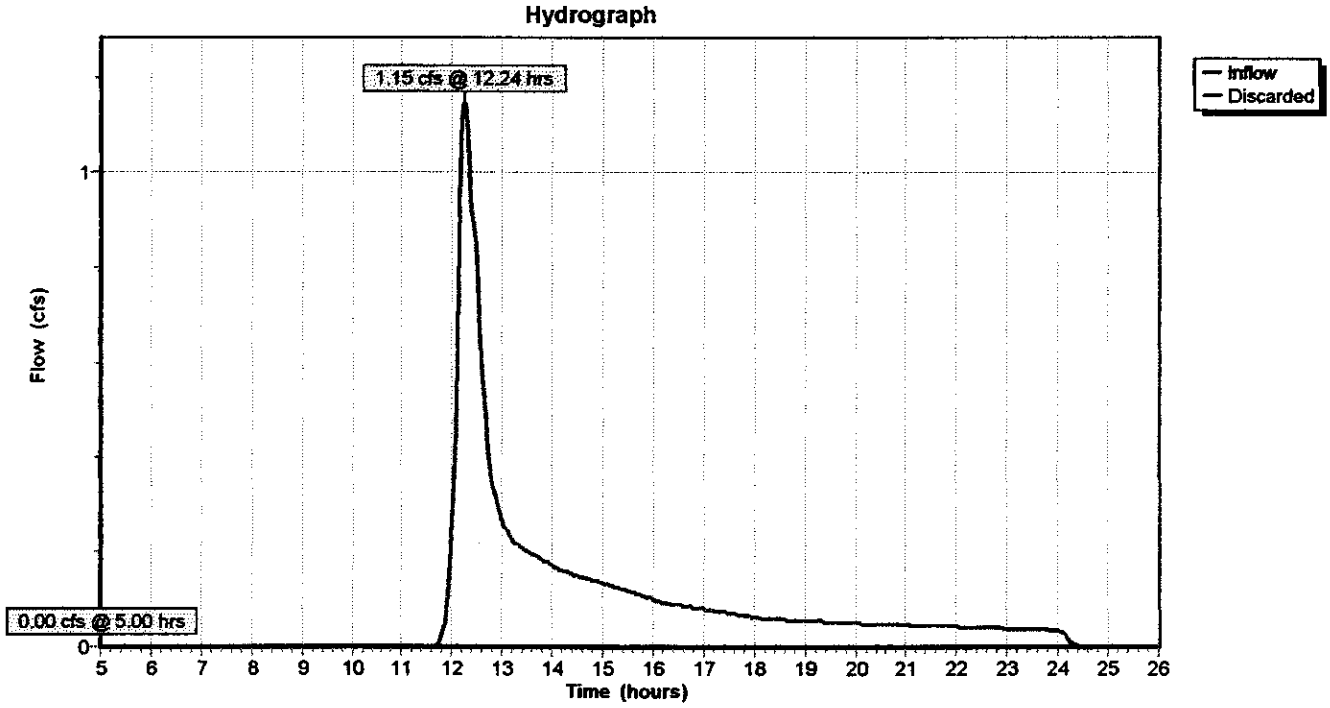
Peak Elev= 164.28' Surf.Area= 7,430 sf Storage= 5,693 cf
Plug-Flow detention time= (not calculated)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
163.00	380	0	0
164.00	6,500	3,440	3,440
165.00	9,880	8,190	11,630

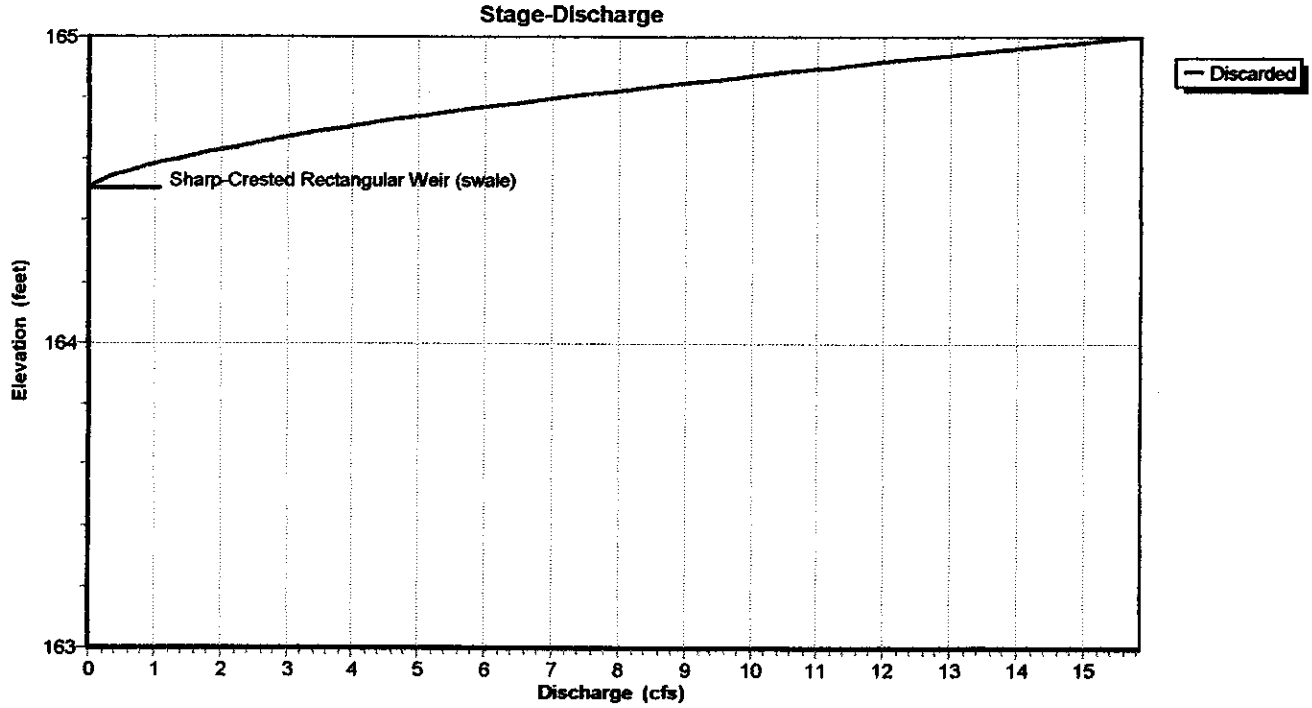
Discarded OutFlow Max=0.00 cfs @ 5.00 hrs HW=163.00' (Free Discharge)
1=Sharp-Crested Rectangular Weir (swale) (Controls 0.00 cfs)

#	Routing	Invert	Outlet Devices
1	Discarded	164.50'	**13.0' long x 1.0' high Sharp-Crested Rectangular Weir (swale)** 2 End Contraction(s)

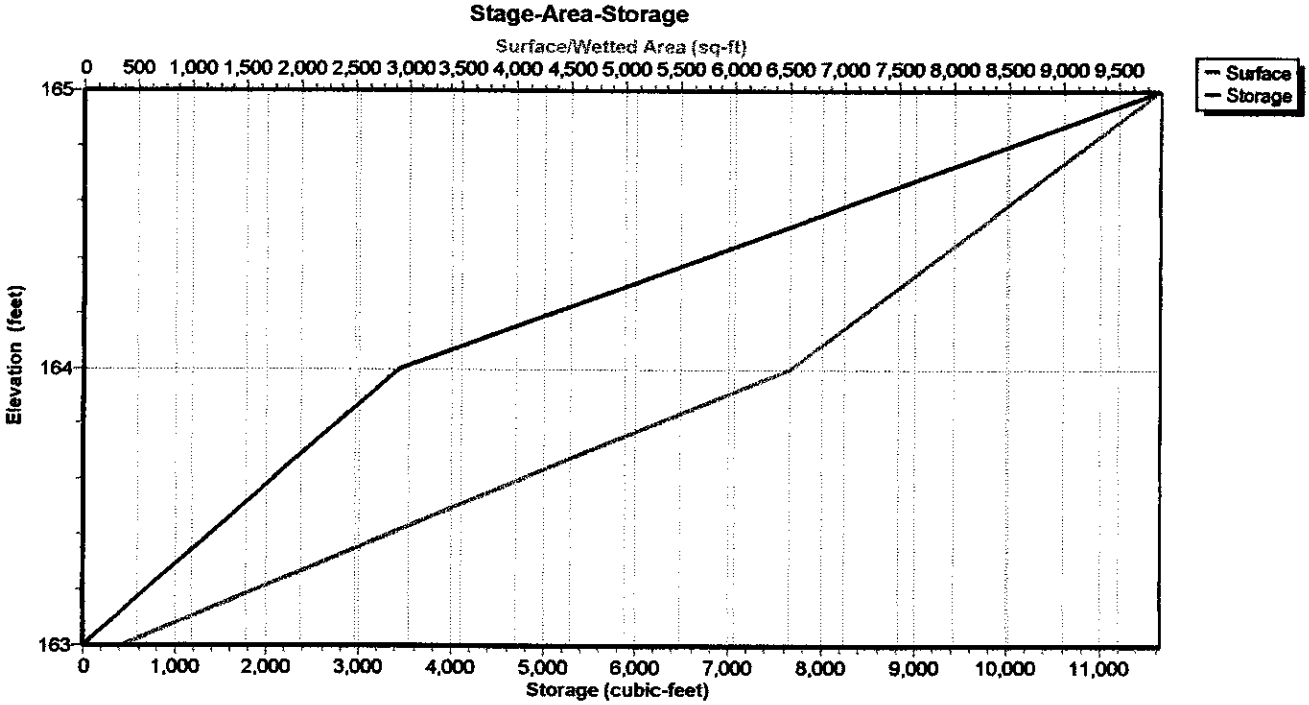
Pond PONDING AREA IN "1S":



Pond PONDING AREA IN "1S":



Pond PONDING AREA IN "1S":



Subcatchment 1S:

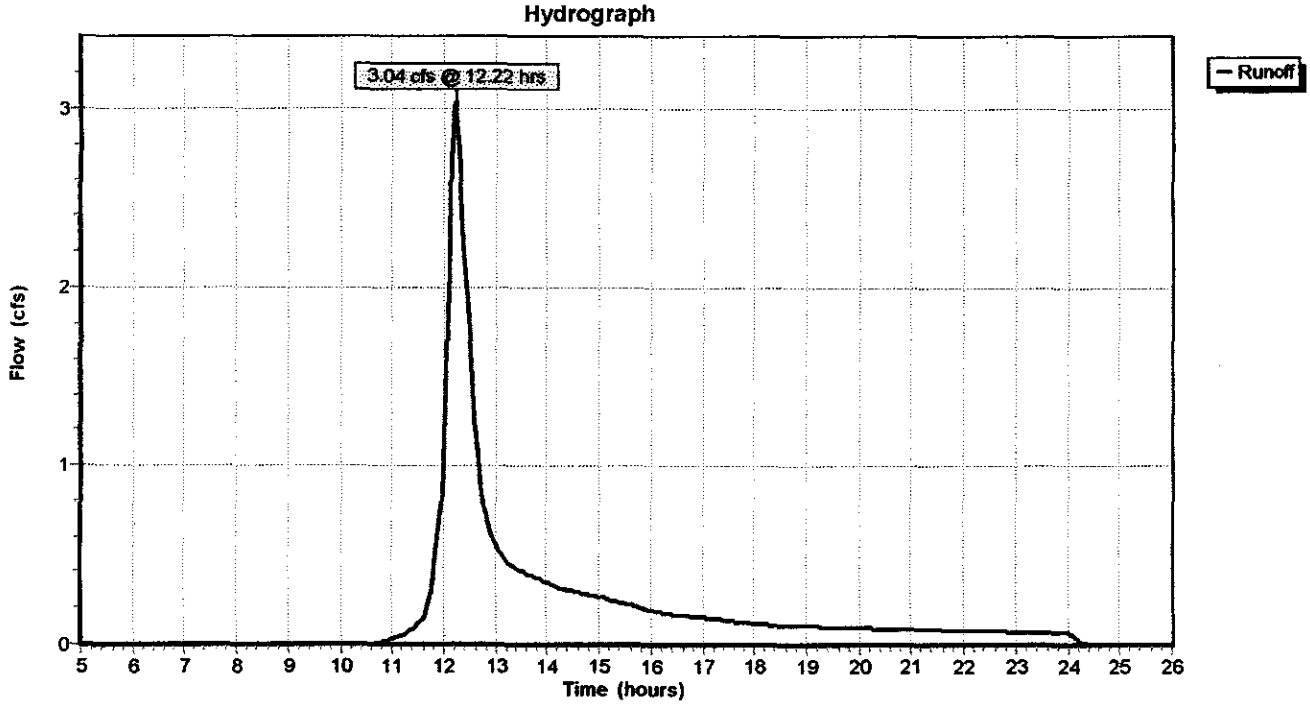
Runoff = 3.04 cfs @ 12.22 hrs, Volume= 0.299 af, Depth= 2.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.170	98	Paved
0.100	98	roofs
0.500	36	Woods, Fair, HSG A
0.570	49	50-75% Grass cover, Fair, HSG A
1.340	54	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	114	0.1200	0.2		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50"
3.0	38	0.0500	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	52	0.0770	1.9		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.5	204	Total			

Subcatchment 1S:



Subcatchment 2S:

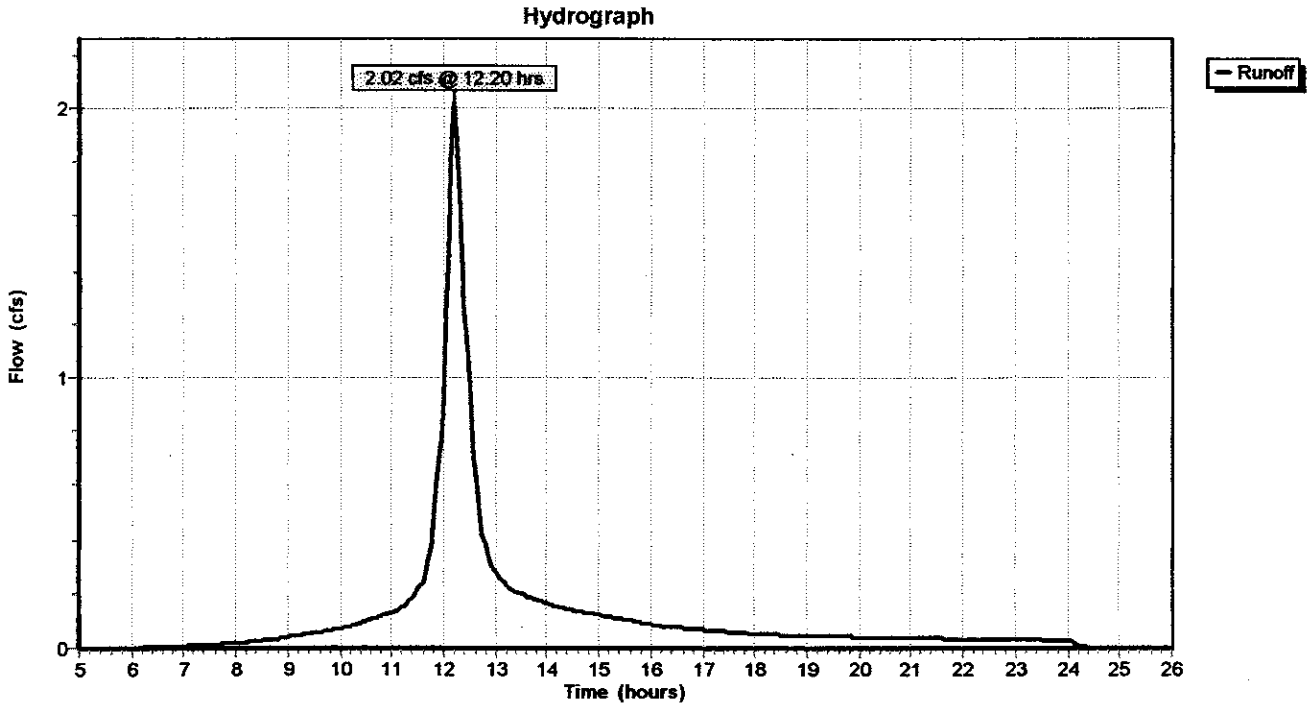
Runoff = 2.02 cfs @ 12.20 hrs, Volume= 0.192 af, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.150	49	50-75% Grass cover, Fair, HSG A
0.410	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

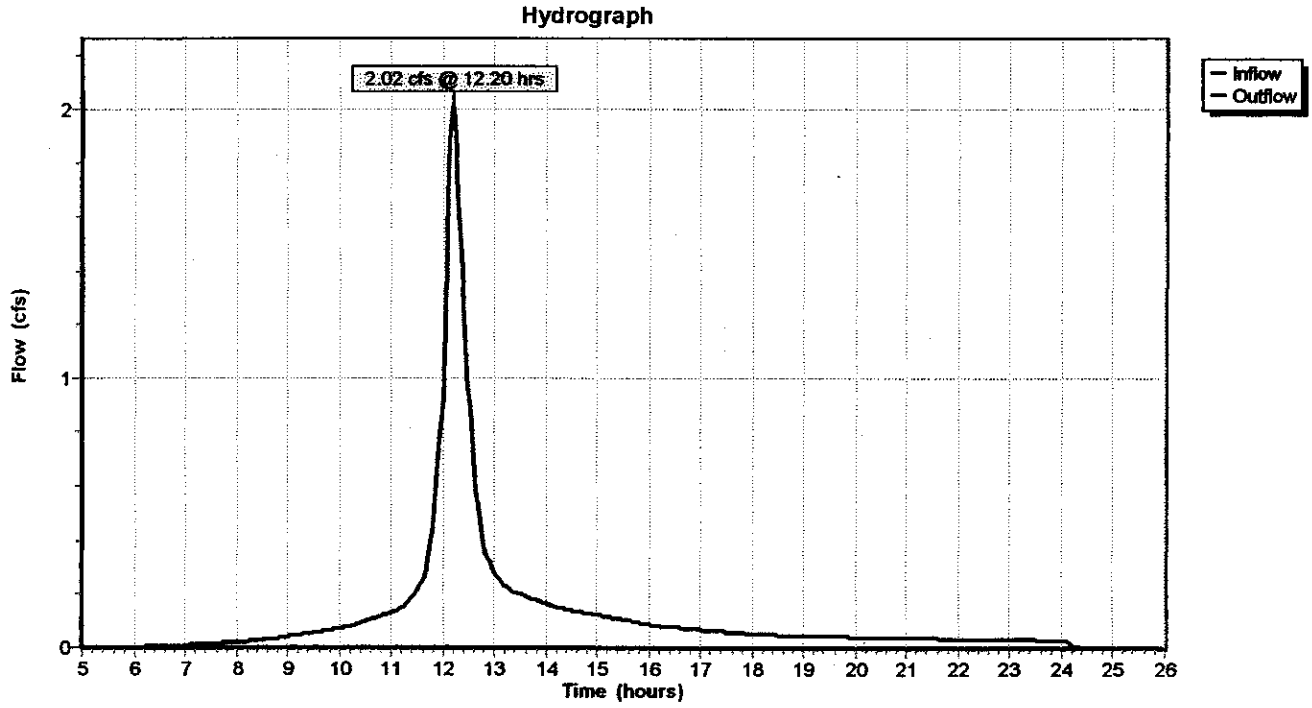


Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.750 ac, Inflow Depth = 1.32"
Inflow = 2.02 cfs @ 12.20 hrs, Volume= 0.192 af
Outflow = 2.02 cfs @ 12.20 hrs, Volume= 0.192 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32



Pond PONDING AREA IN "1S":

Inflow Area = 1.340 ac, Inflow Depth = 2.68"
Inflow = 3.04 cfs @ 12.22 hrs, Volume= 0.299 af
Outflow = 0.32 cfs @ 14.21 hrs, Volume= 0.126 af, Atten= 90%, Lag= 119.9 min
Discarded = 0.32 cfs @ 14.21 hrs, Volume= 0.126 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

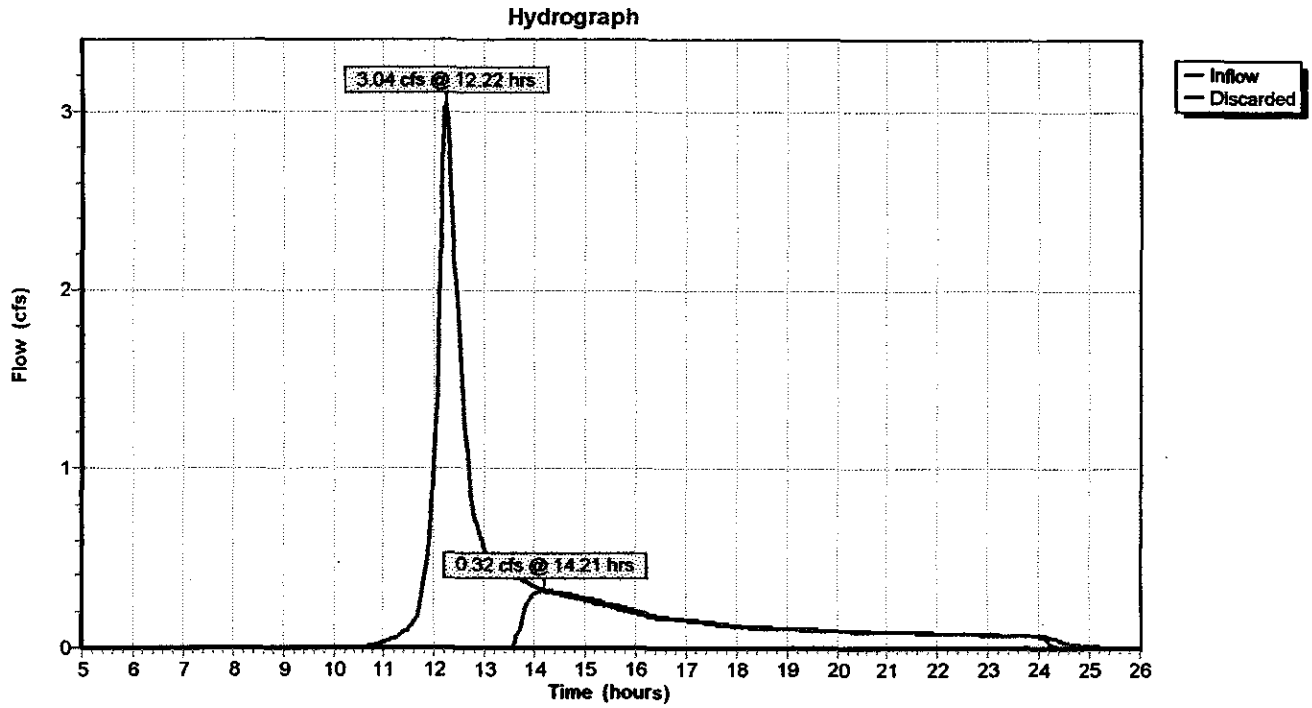
Peak Elev= 164.54' Surf.Area= 8,318 sf Storage= 7,844 cf
Plug-Flow detention time= 323.3 min calculated for 0.126 af (42% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
163.00	380	0	0
164.00	6,500	3,440	3,440
165.00	9,880	8,190	11,630

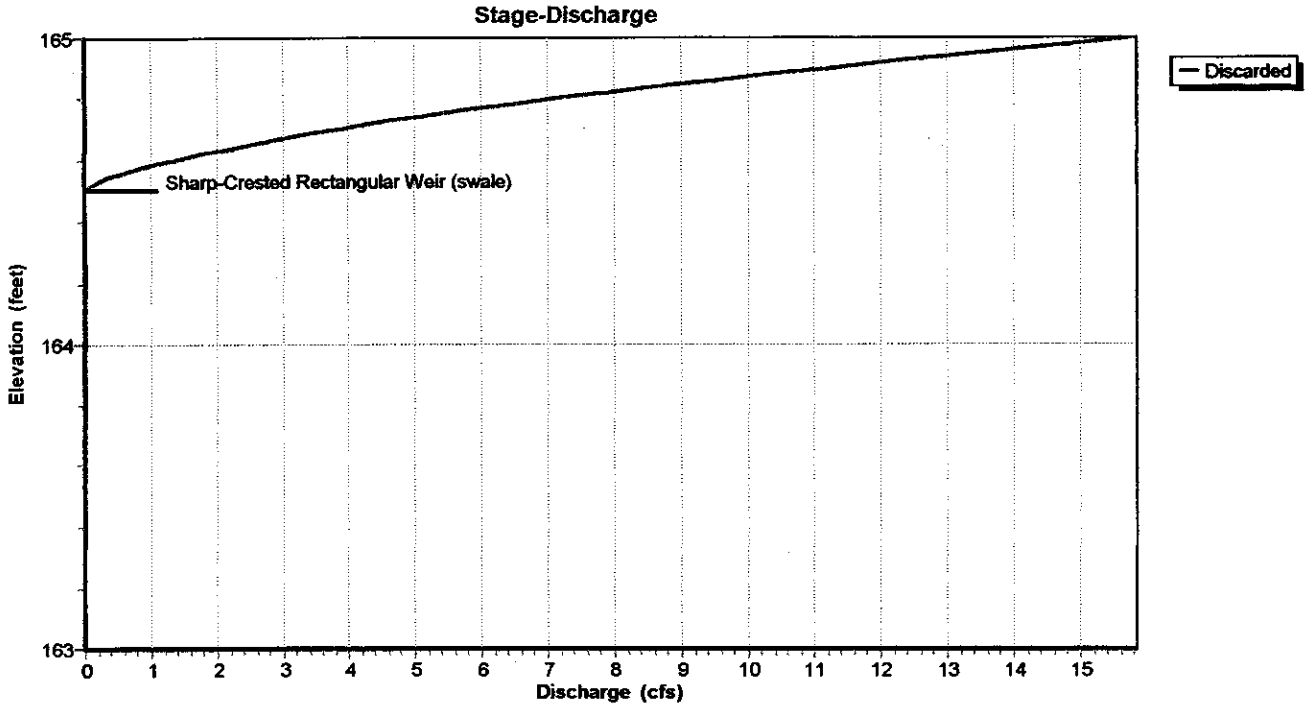
Discarded OutFlow Max=0.31 cfs @ 14.21 hrs HW=164.54' (Free Discharge)
↑—**1=Sharp-Crested Rectangular Weir (swale)** (Controls 0.31 cfs)

#	Routing	Invert	Outlet Devices
1	Discarded	164.50'	**13.0' long x 1.0' high Sharp-Crested Rectangular Weir (swale)** 2 End Contraction(s)

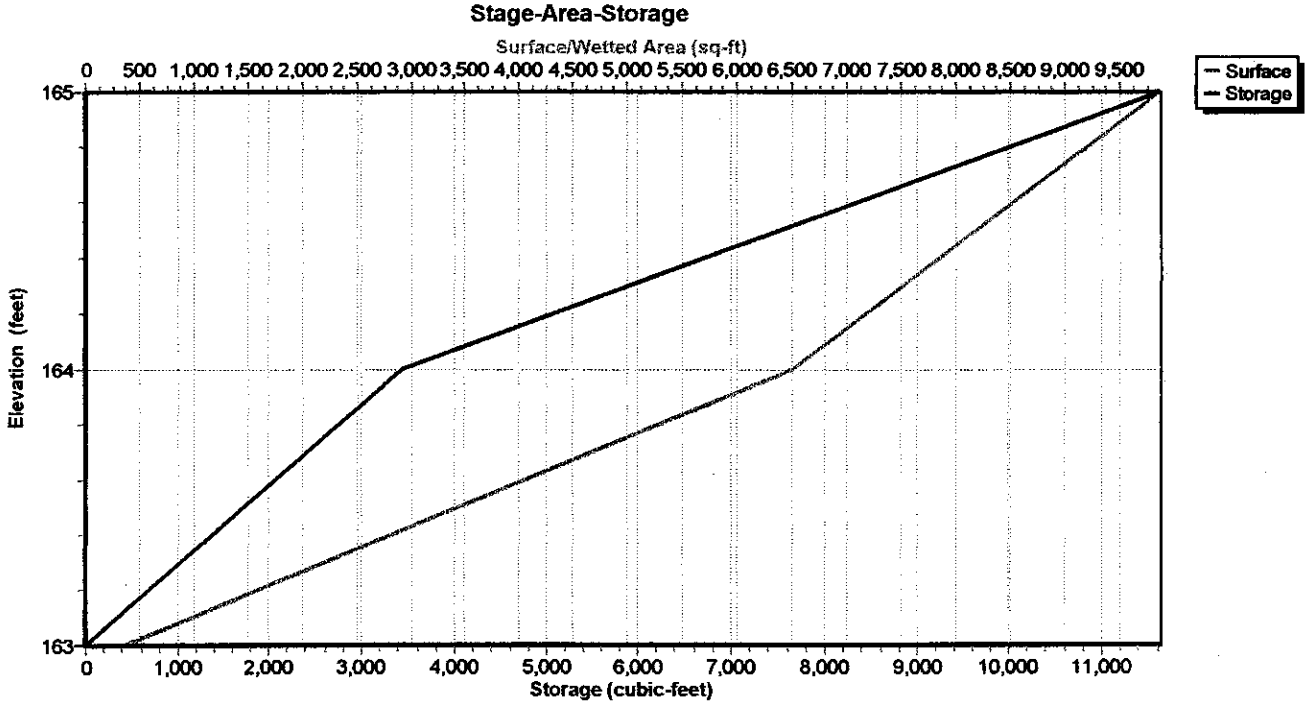
Pond PONDING AREA IN "1S":



Pond PONDING AREA IN "1S":

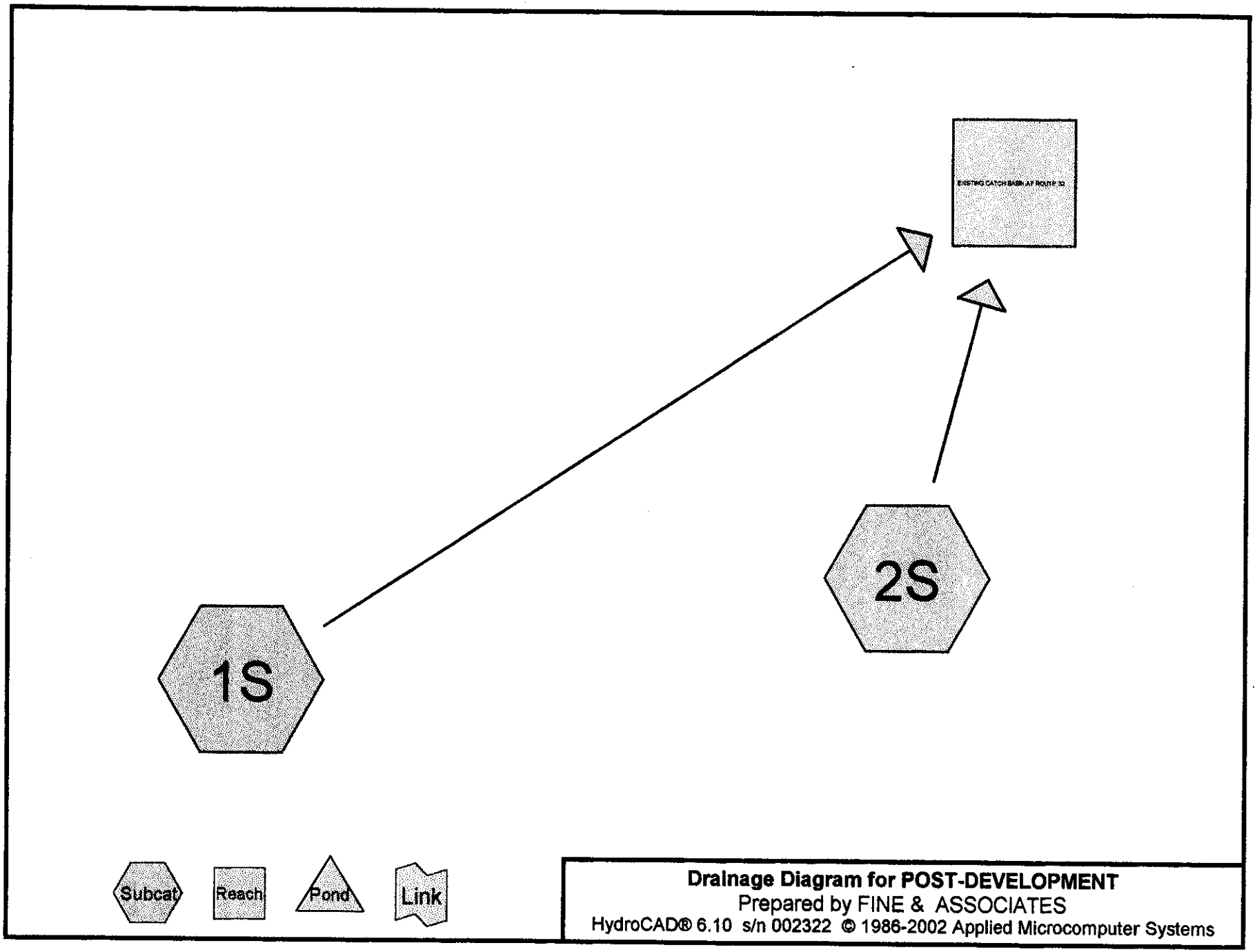


Pond PONDING AREA IN "1S":



APPENDIX B

HYDROCAD POST-DEVELOPED CALCULATION



Drainage Diagram for POST-DEVELOPMENT
Prepared by FINE & ASSOCIATES

Subcatchment 1S:

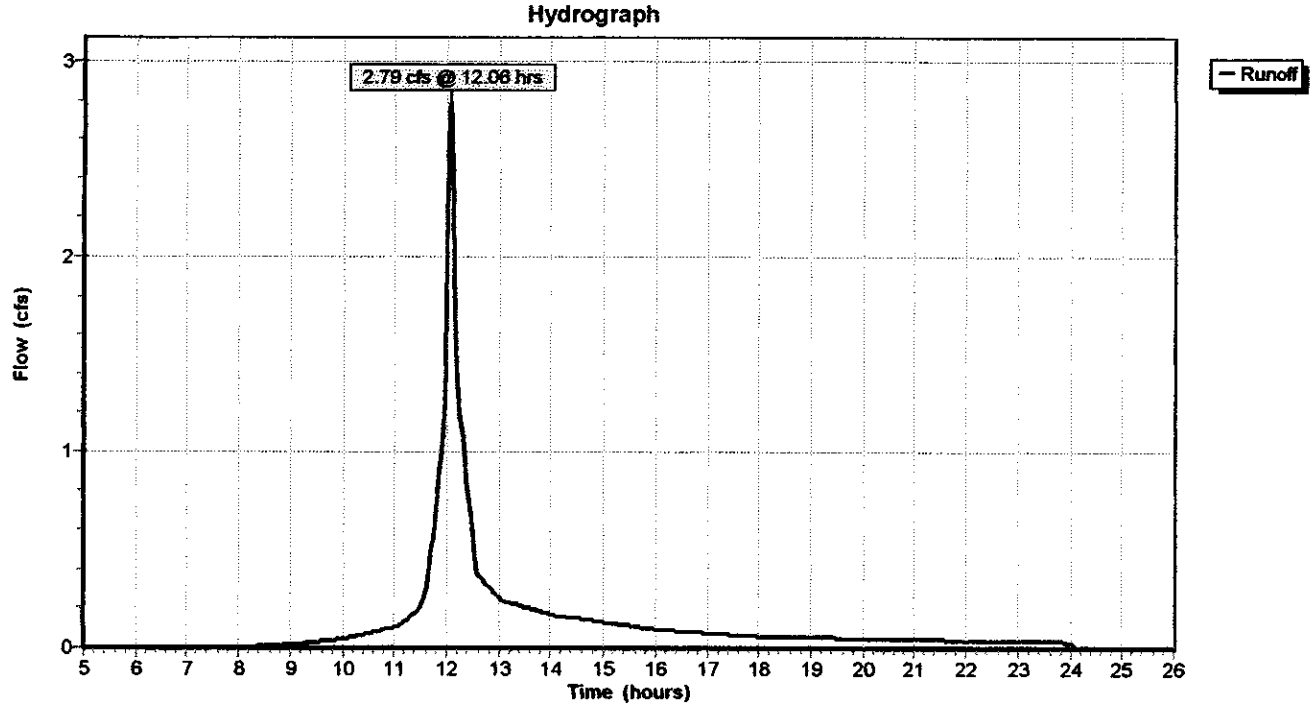
Runoff = 2.79 cfs @ 12.06 hrs, Volume= 0.188 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

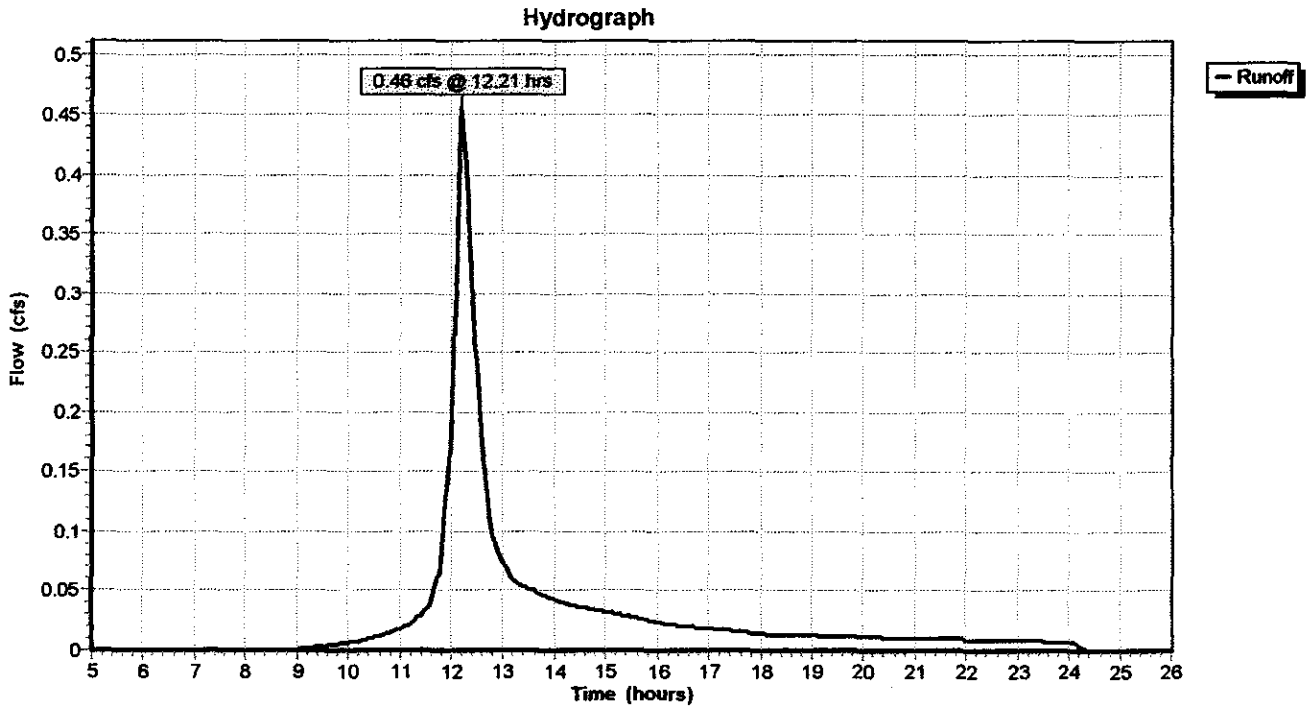
Runoff = 0.46 cfs @ 12.21 hrs, Volume= 0.043 af, Depth= 1.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

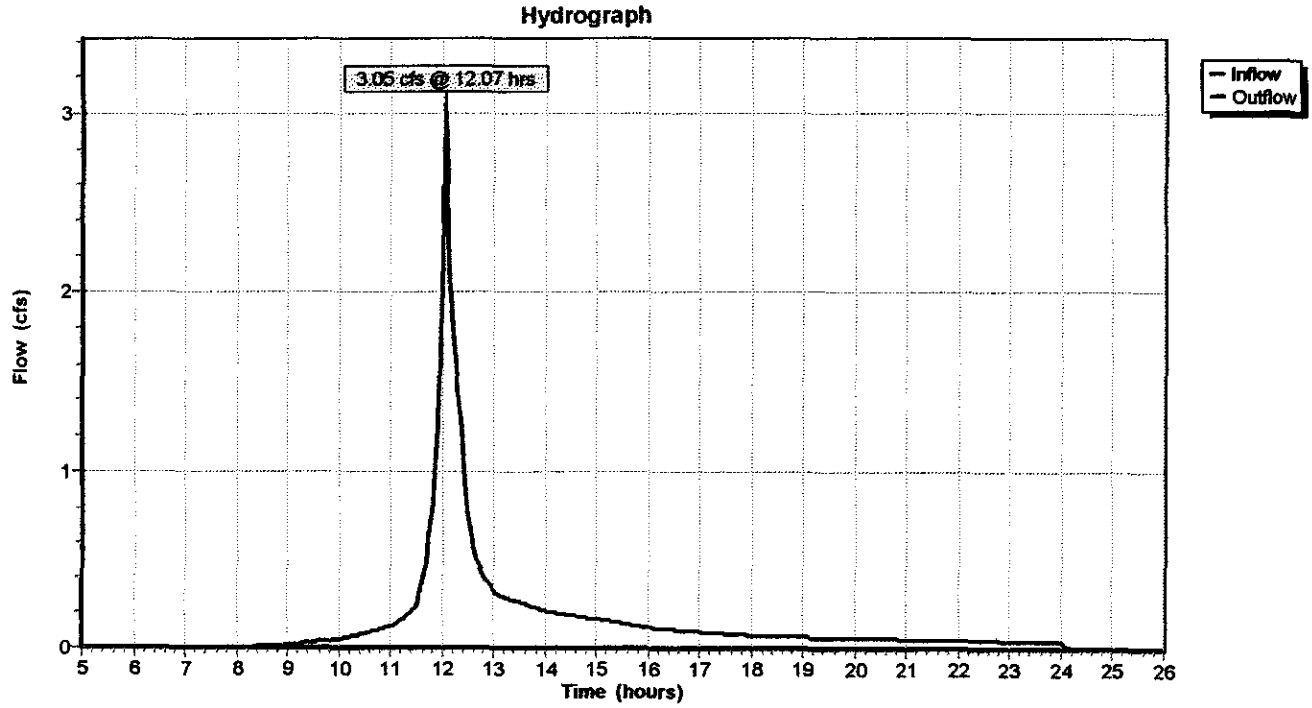


Reach EXISTING CATCH BASIN AT ROUTE 32:

Inflow Area = 1.790 ac, Inflow Depth = 1.55"
Inflow = 3.05 cfs @ 12.07 hrs, Volume= 0.231 af
Outflow = 3.05 cfs @ 12.07 hrs, Volume= 0.231 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach EXISTING CATCH BASIN AT ROUTE 32:



Subcatchment 1S:

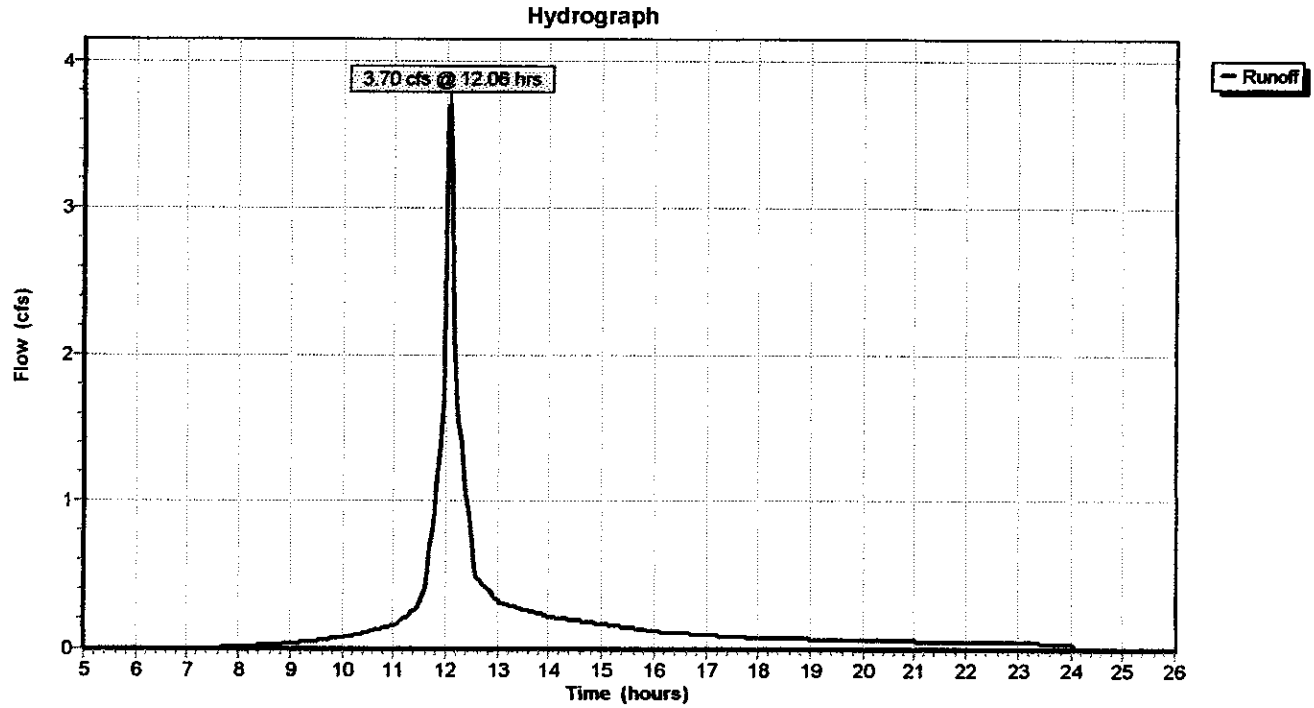
Runoff = 3.70 cfs @ 12.06 hrs, Volume= 0.250 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.50"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

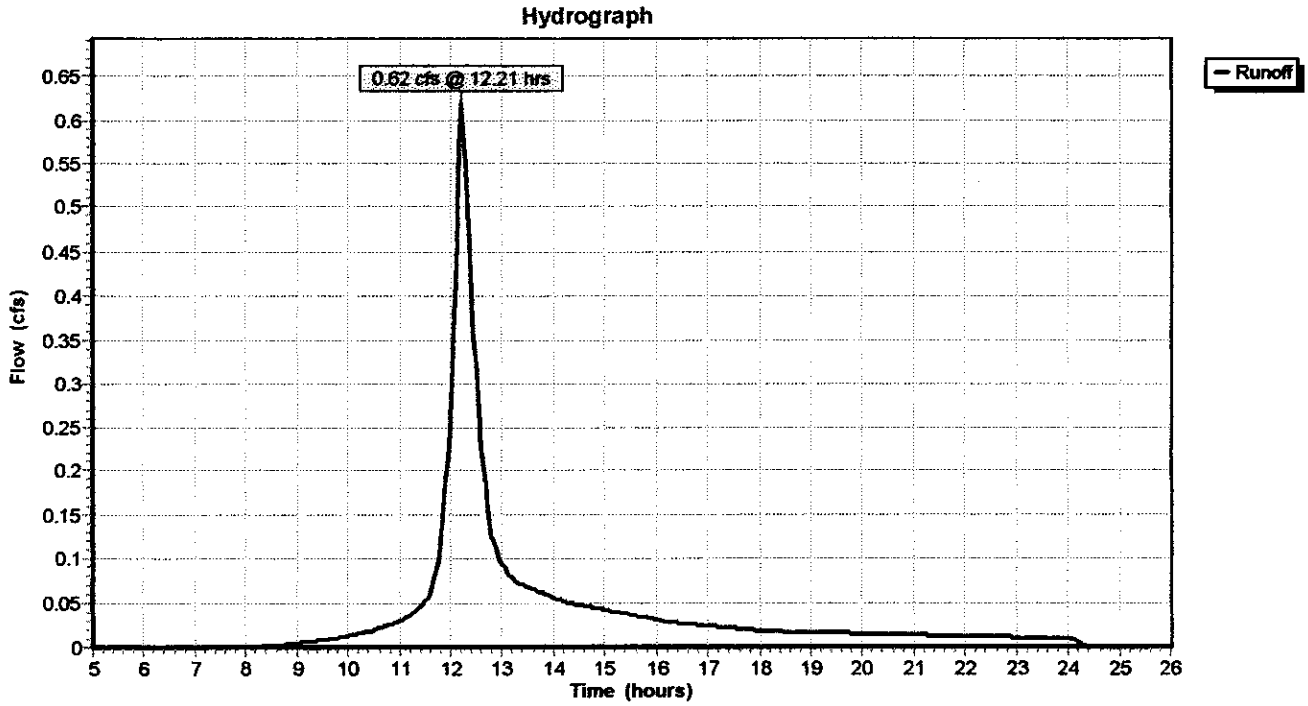
Runoff = 0.62 cfs @ 12.21 hrs, Volume= 0.058 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.50"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

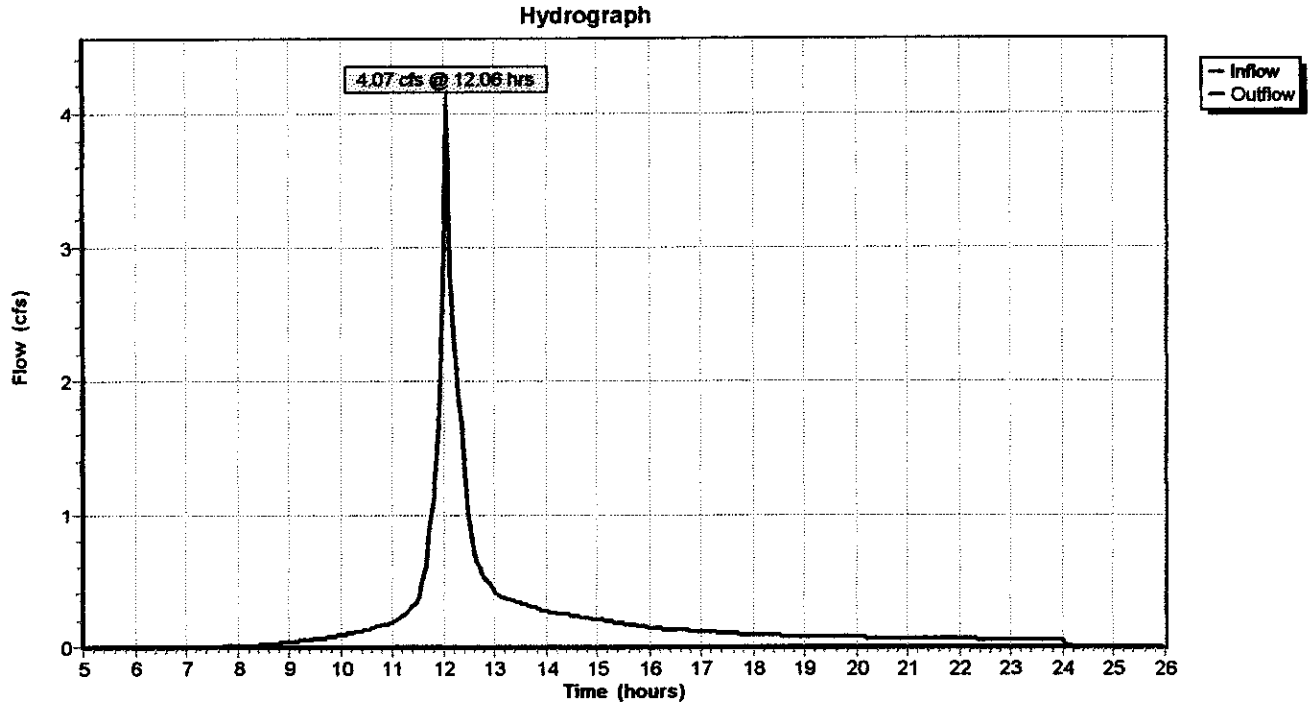


Reach EXISTING CATCH BASIN AT ROUTE 32:

Inflow Area = 1.790 ac, Inflow Depth = 2.07"
Inflow = 4.07 cfs @ 12.06 hrs, Volume= 0.308 af
Outflow = 4.07 cfs @ 12.06 hrs, Volume= 0.308 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach EXISTING CATCH BASIN AT ROUTE 32:



Subcatchment 1S:

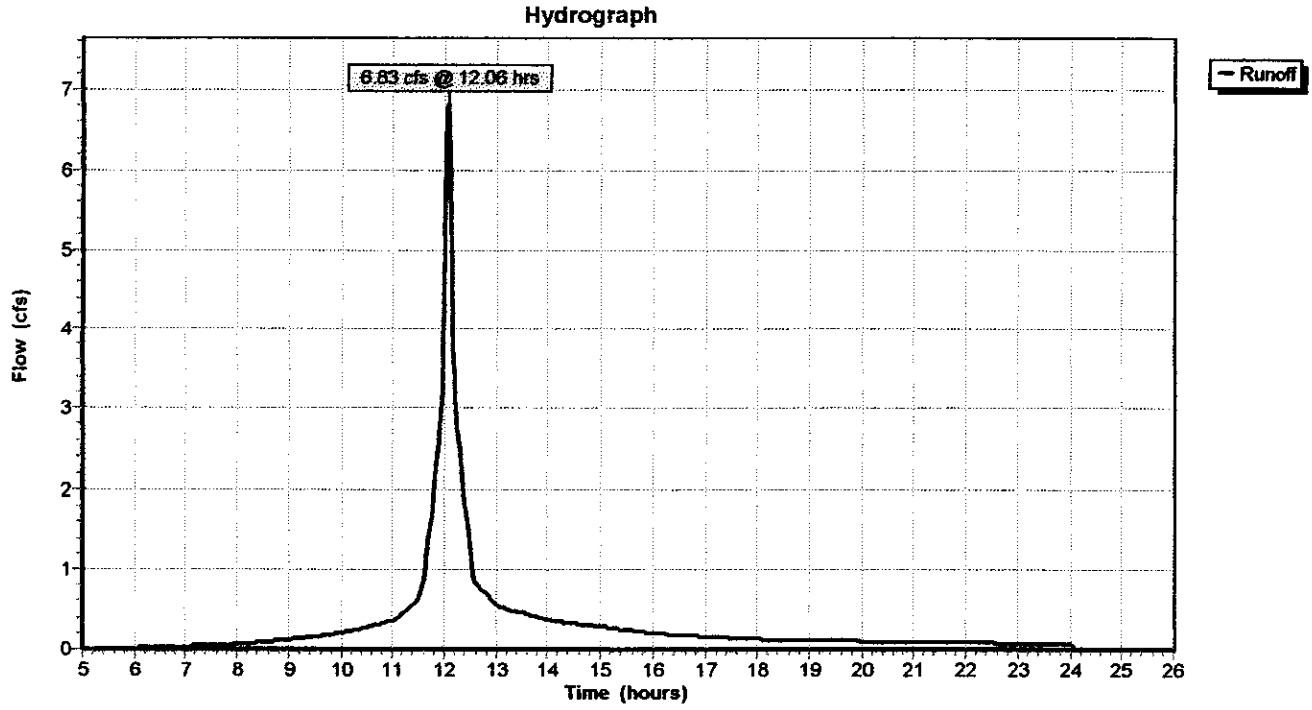
Runoff = 6.83 cfs @ 12.06 hrs, Volume= 0.469 af, Depth= 3.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.50"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

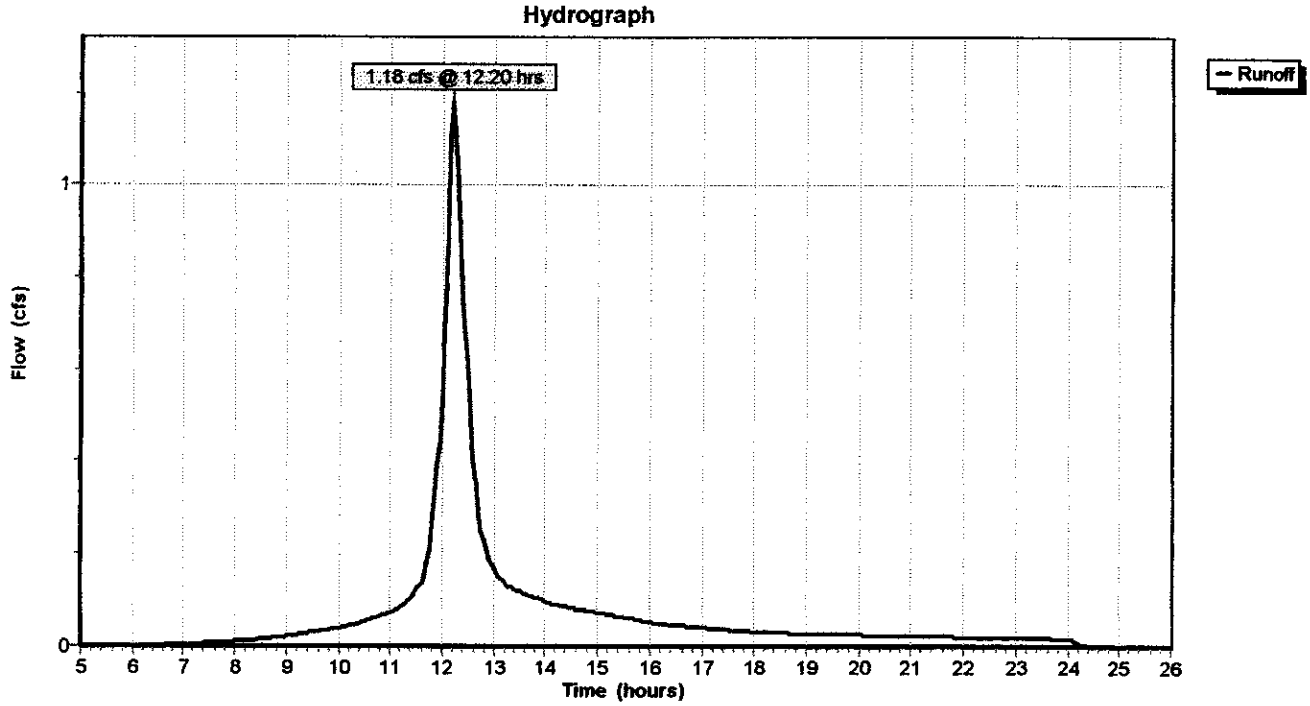
Runoff = 1.18 cfs @ 12.20 hrs, Volume= 0.112 af, Depth= 3.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.50"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

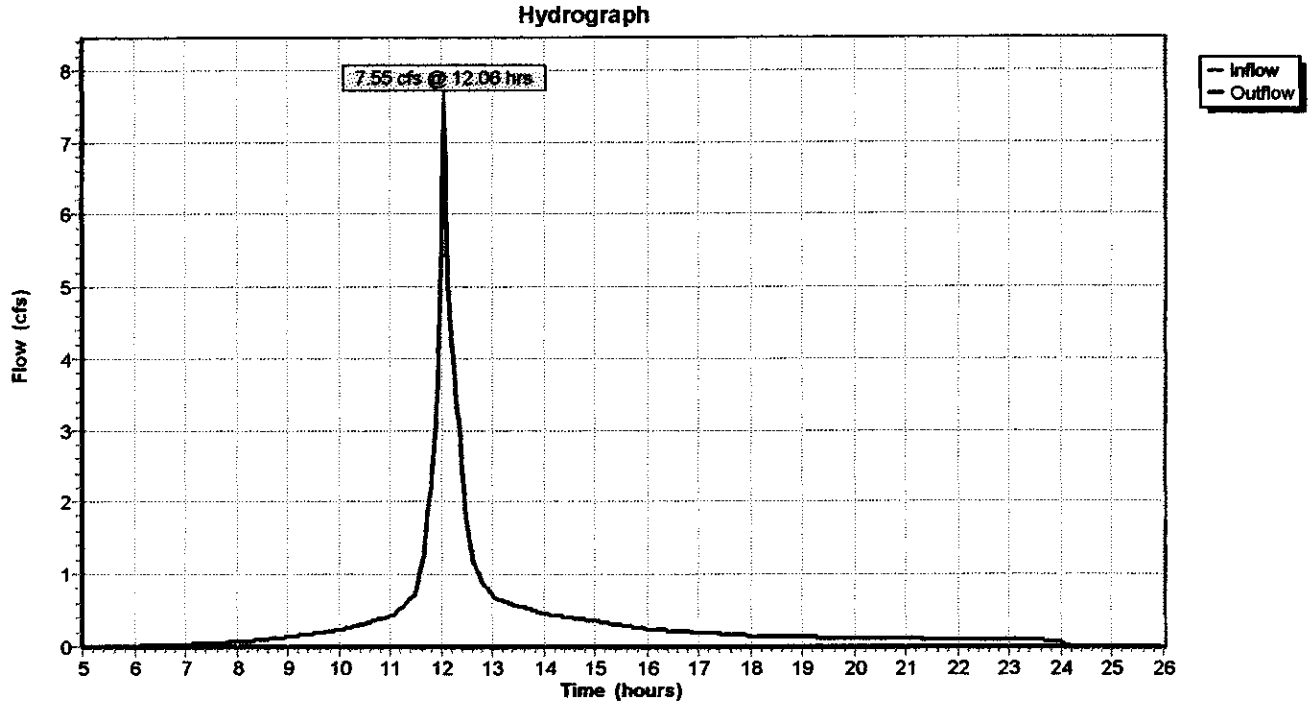


Reach EXISTING CATCH BASIN AT ROUTE 32:

Inflow Area = 1.790 ac, Inflow Depth = 3.89"
Inflow = 7.55 cfs @ 12.06 hrs, Volume= 0.581 af
Outflow = 7.55 cfs @ 12.06 hrs, Volume= 0.581 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach EXISTING CATCH BASIN AT ROUTE 32:



Subcatchment 1S:

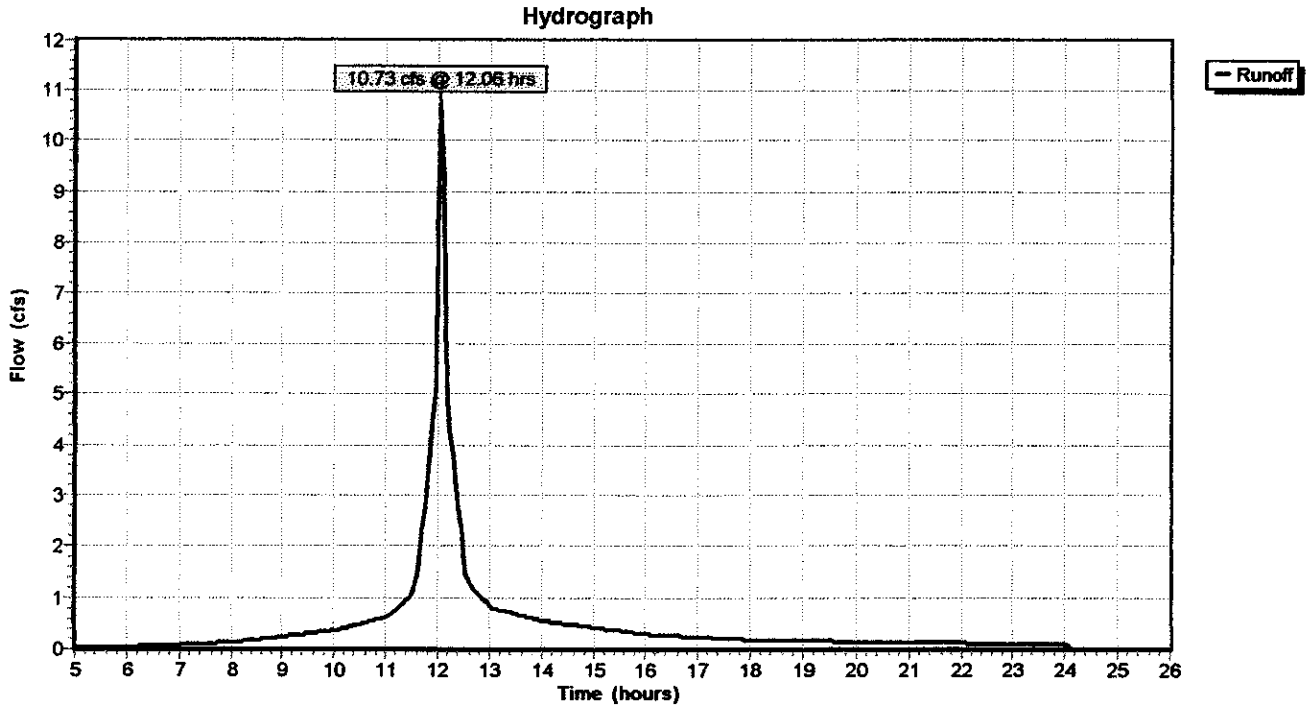
Runoff = 10.73 cfs @ 12.06 hrs, Volume= 0.754 af, Depth= 6.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

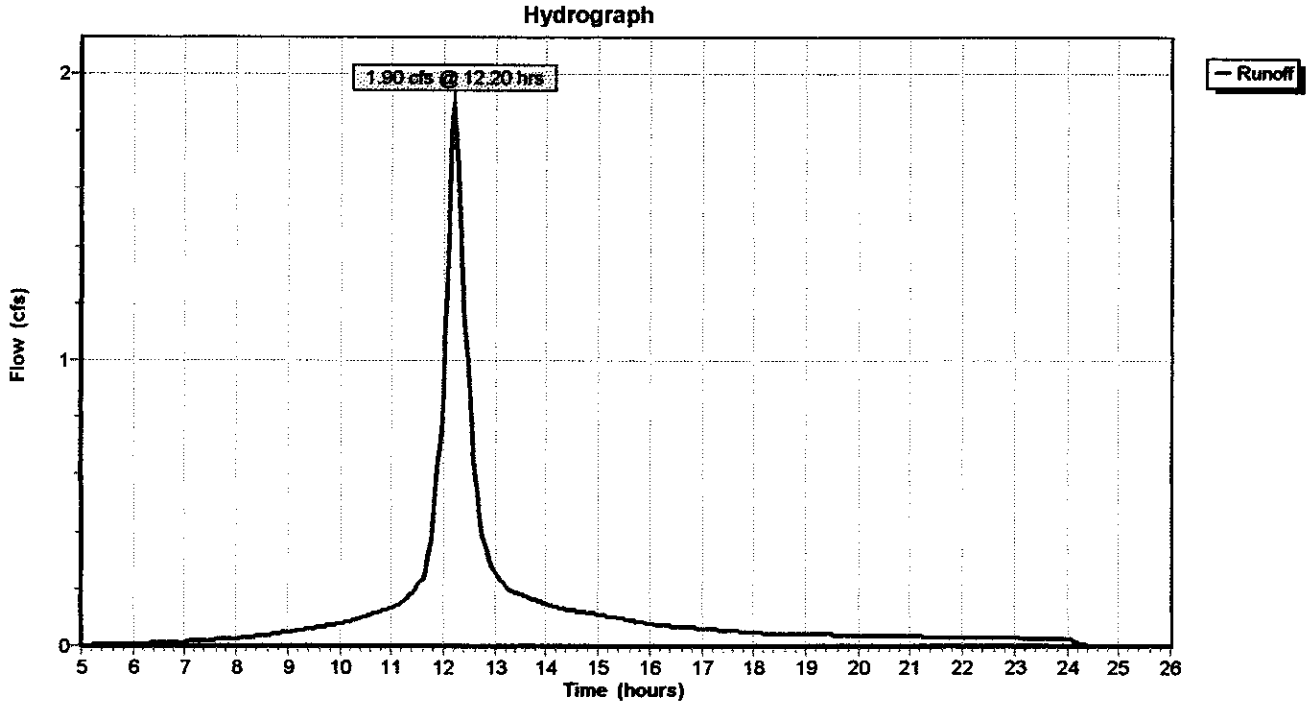
Runoff = 1.90 cfs @ 12.20 hrs, Volume= 0.183 af, Depth= 6.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

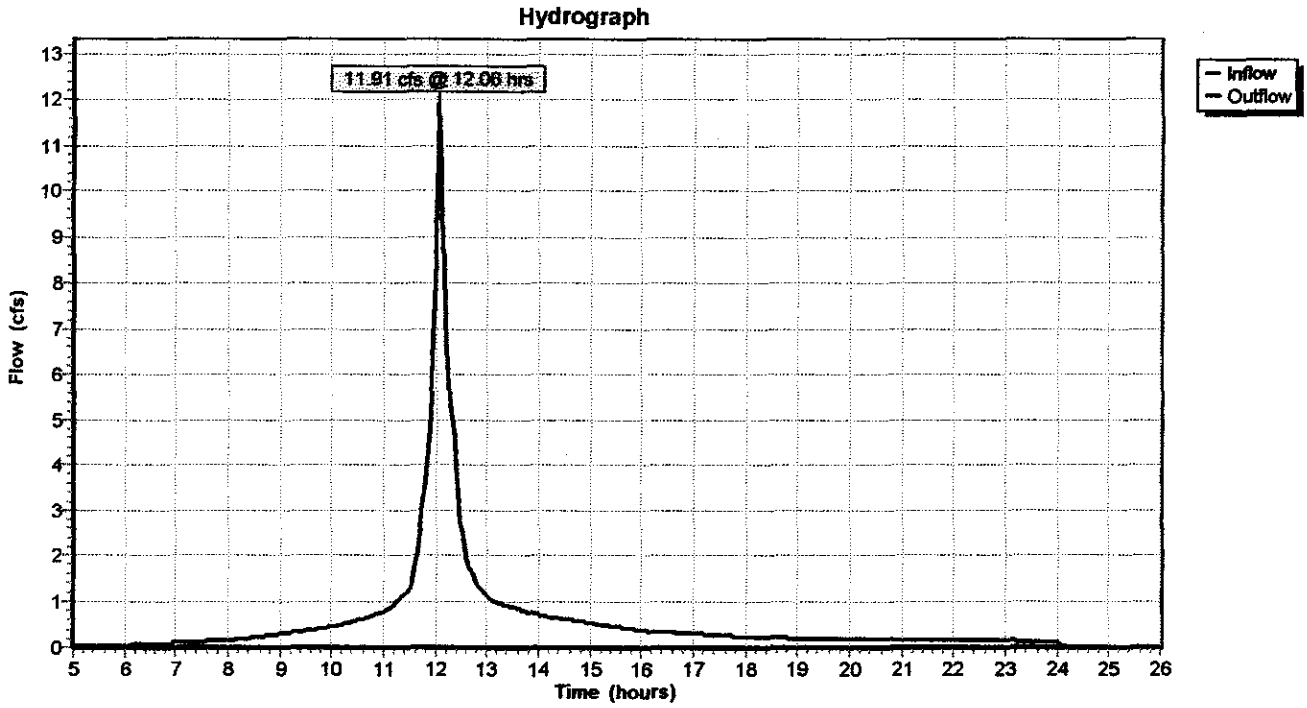


Reach EXISTING CATCH BASIN AT ROUTE 32:

Inflow Area = 1.790 ac, Inflow Depth = 6.28"
Inflow = 11.91 cfs @ 12.06 hrs, Volume= 0.936 af
Outflow = 11.91 cfs @ 12.06 hrs, Volume= 0.936 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

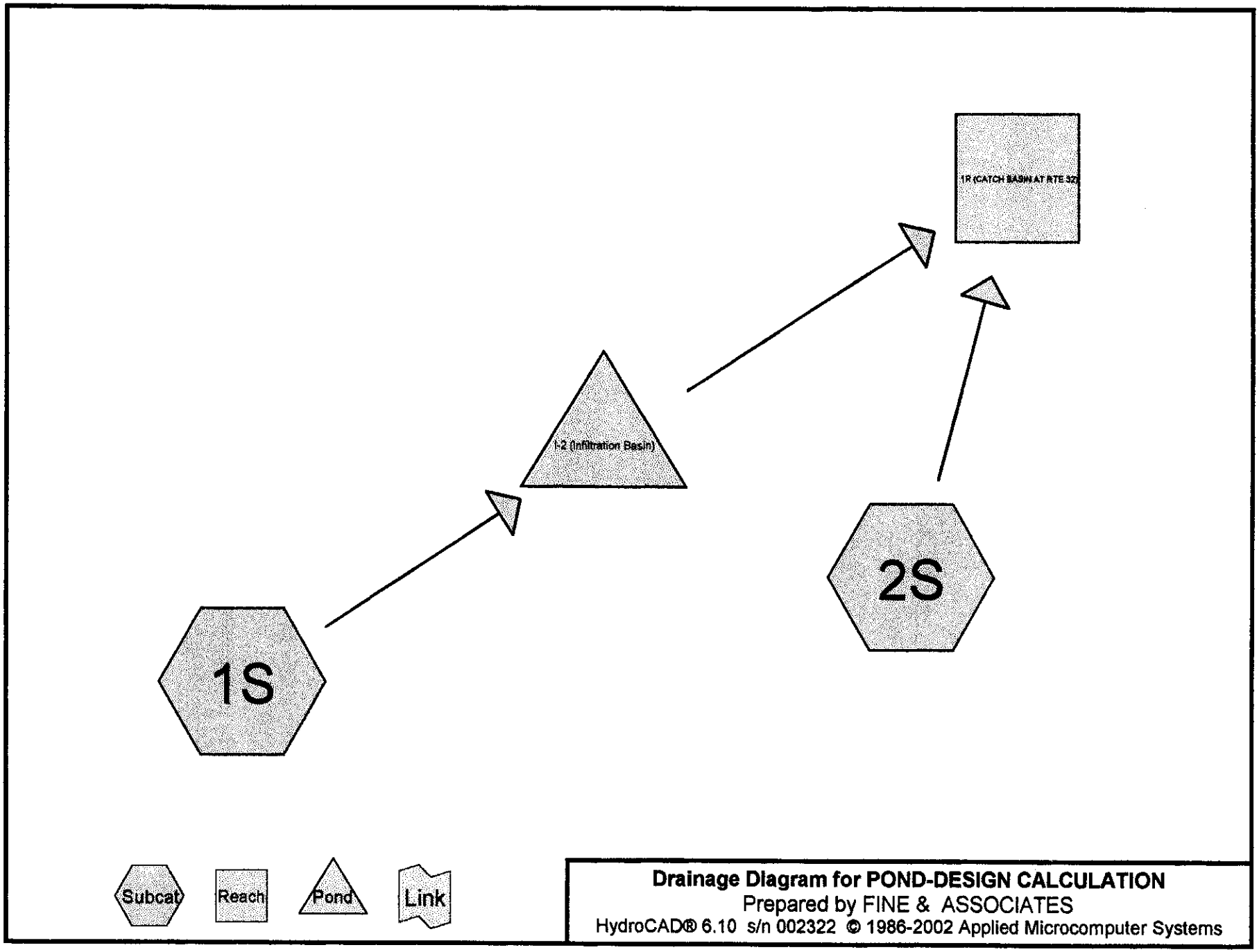
Reach EXISTING CATCH BASIN AT ROUTE 32:



APPENDIX C

HYDROCAD POND DESIGN CALCULATION

STORM WATER QUANTITY AND QUALITY CALCULATION WITH THE SUPORTING DATA



Drainage Diagram for POND-DESIGN CALCULATION
Prepared by FINE & ASSOCIATES

Subcatchment 1S:

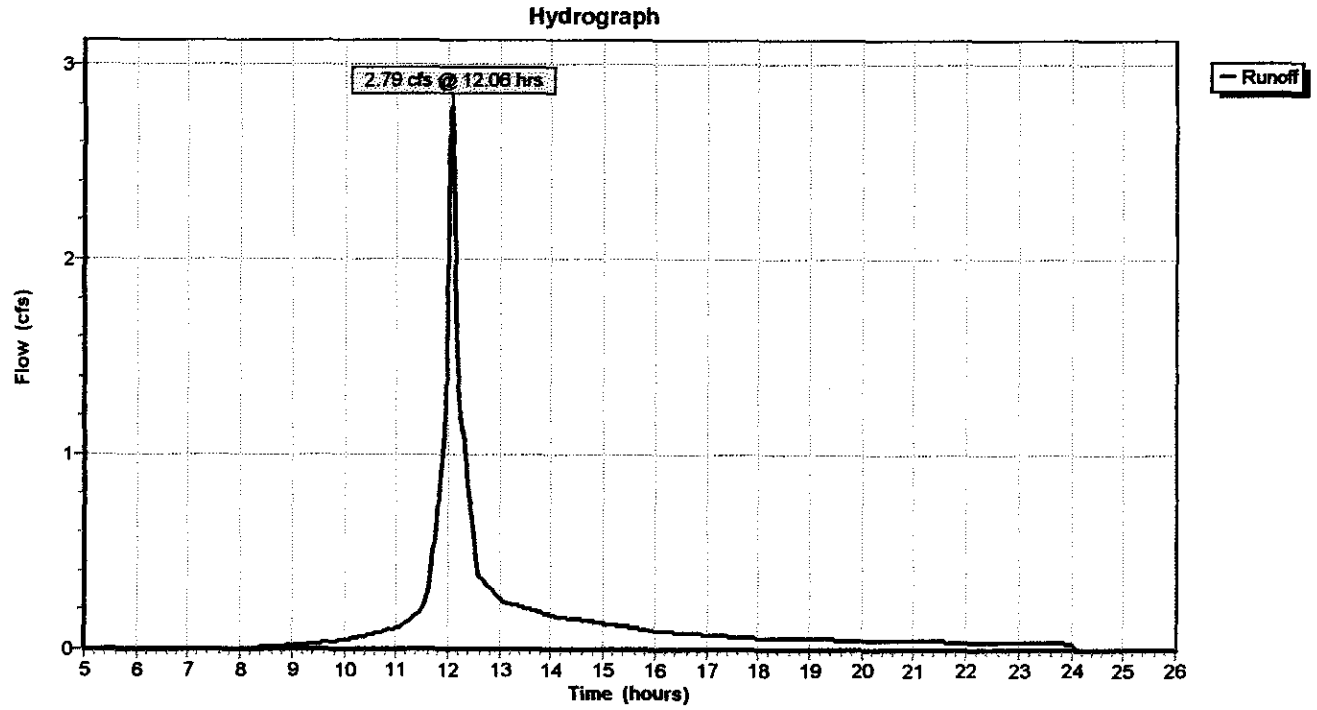
Runoff = 2.79 cfs @ 12.06 hrs, Volume= 0.188 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

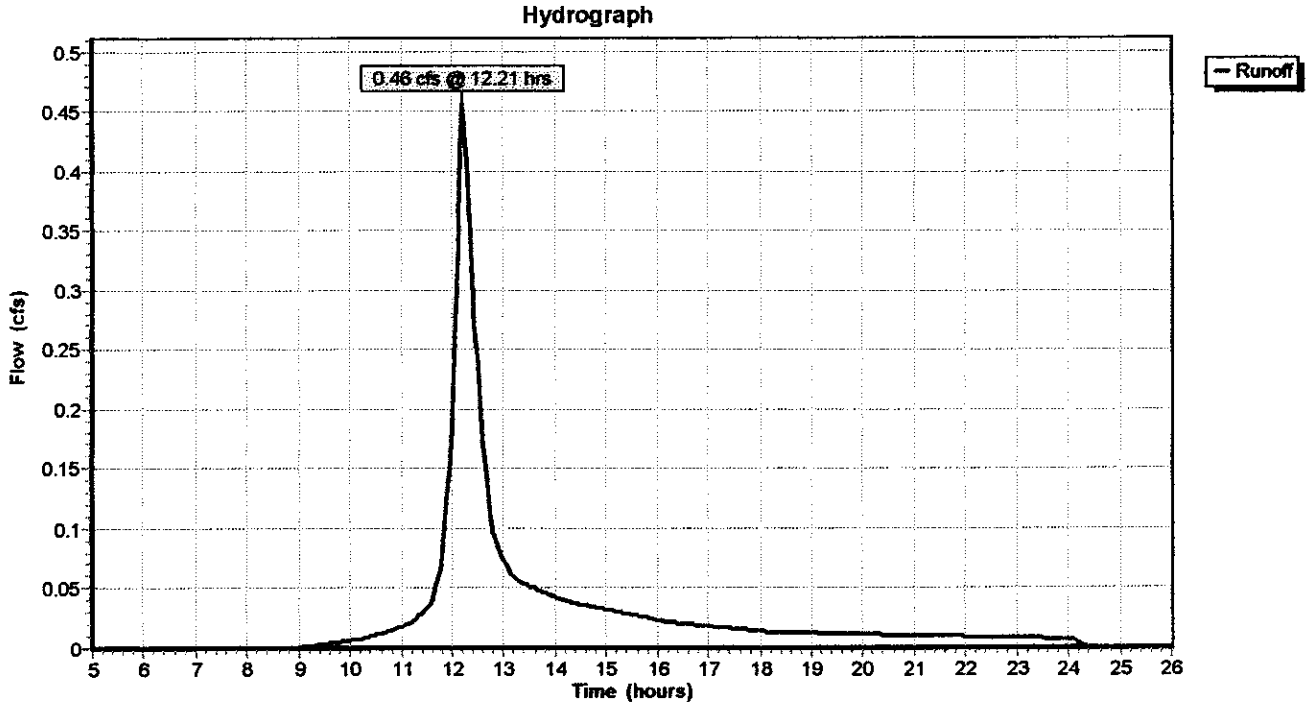
Runoff = 0.46 cfs @ 12.21 hrs, Volume= 0.043 af, Depth= 1.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

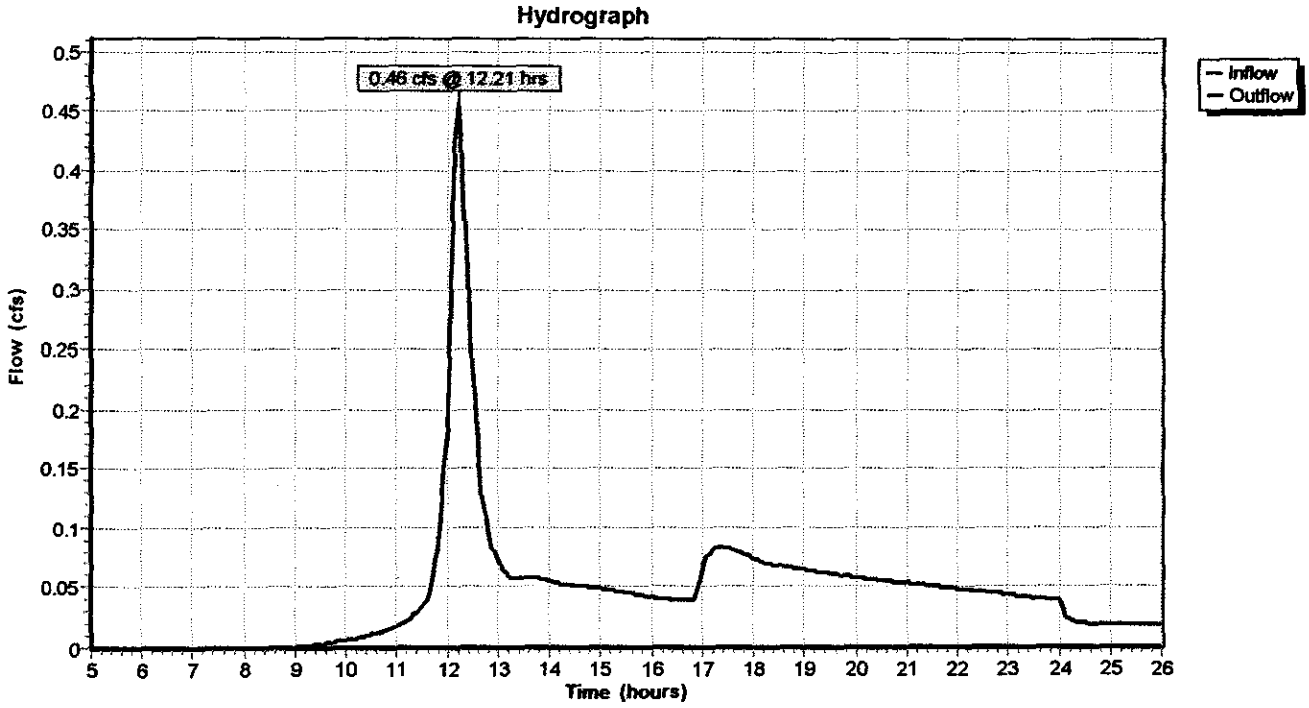


Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.790 ac, Inflow Depth = 0.52"
Inflow = 0.46 cfs @ 12.21 hrs, Volume= 0.078 af
Outflow = 0.46 cfs @ 12.21 hrs, Volume= 0.078 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32



Pond I-2 (Infiltration Basin):

Inflow Area = 1.430 ac, Inflow Depth = 1.58"
Inflow = 2.79 cfs @ 12.06 hrs, Volume= 0.188 af
Outflow = 0.07 cfs @ 17.42 hrs, Volume= 0.035 af, Atten= 98%, Lag= 321.7 min
Primary = 0.07 cfs @ 17.42 hrs, Volume= 0.035 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

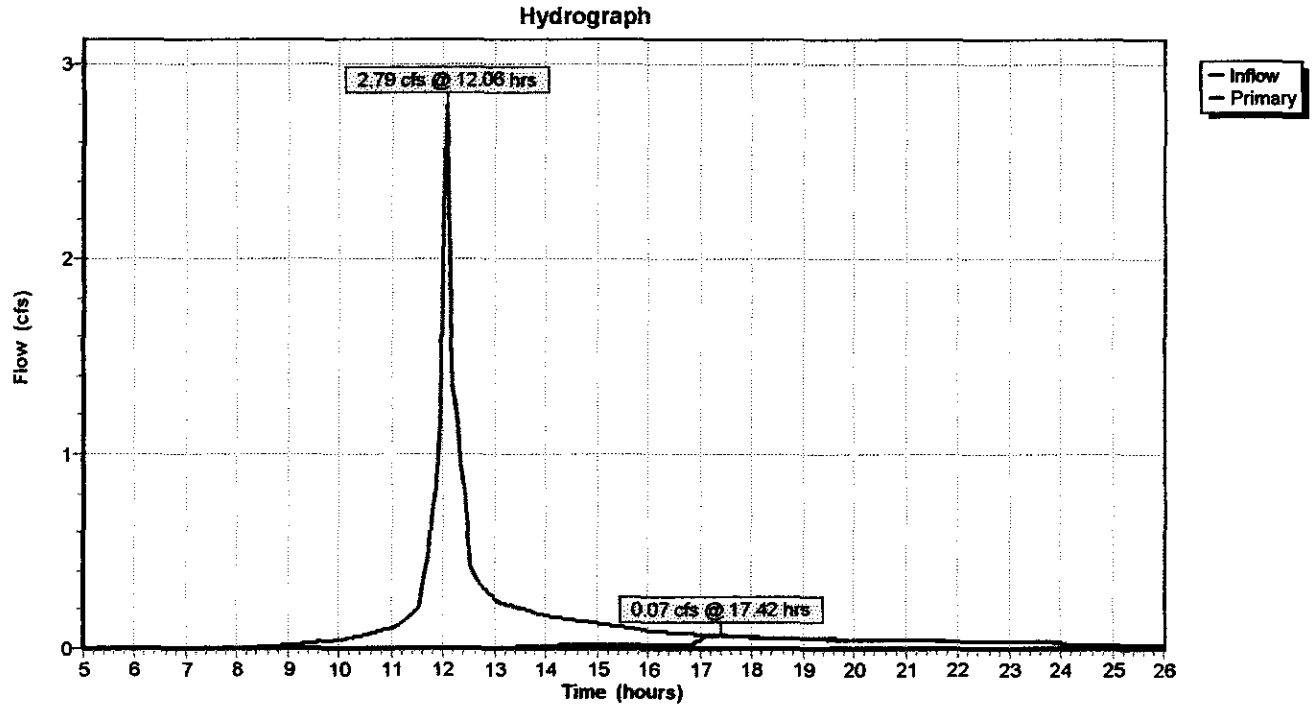
Peak Elev= 164.36' Storage= 6,829 cf
Plug-Flow detention time= 515.9 min calculated for 0.035 af (19% of inflow)

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	0	0
162.00	1,769	1,769
164.00	3,977	5,746
165.00	3,002	8,748

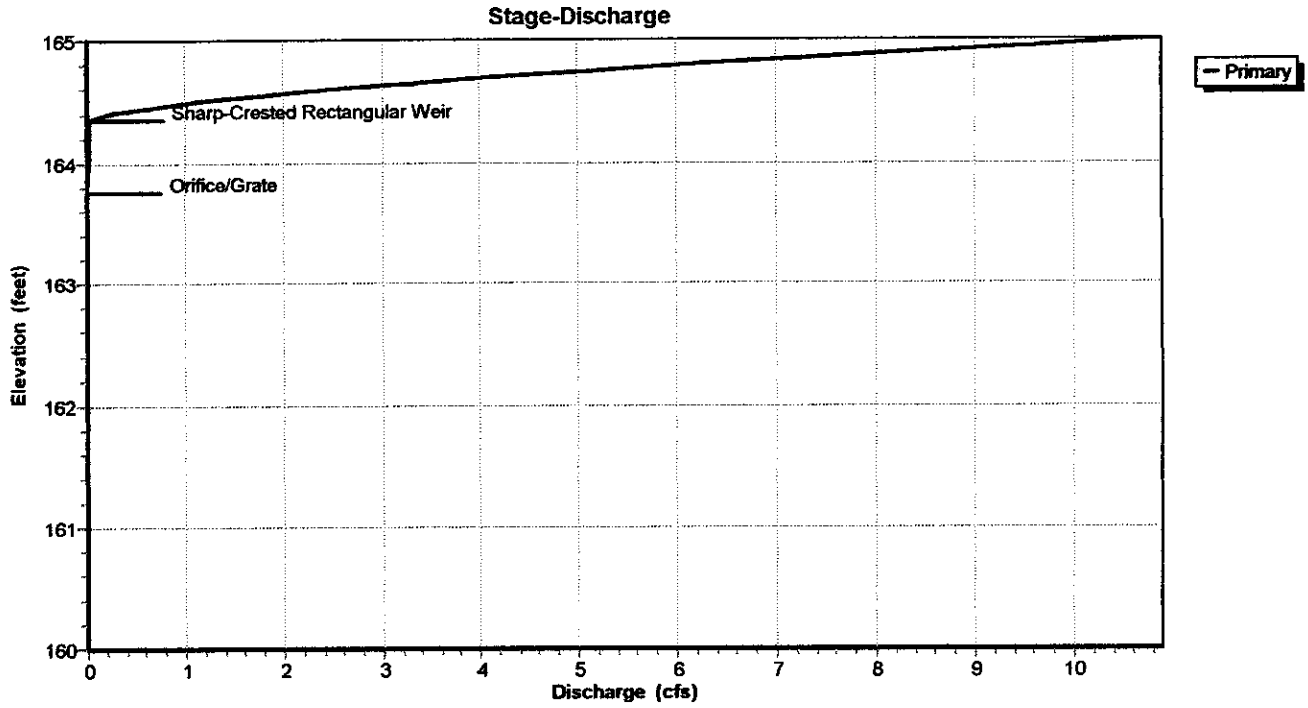
Primary OutFlow Max=0.04 cfs @ 17.42 hrs HW=164.36' (Free Discharge)
1=Orifice/Grate (Controls 0.02 cfs)
2=Sharp-Crested Rectangular Weir (Controls 0.02 cfs)

#	Routing	Invert	Outlet Devices
1	Primary	163.75'	**1.0" Vert. Orifice/Grate** C= 0.600
2	Primary	164.35'	**6.0' long x 1.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)

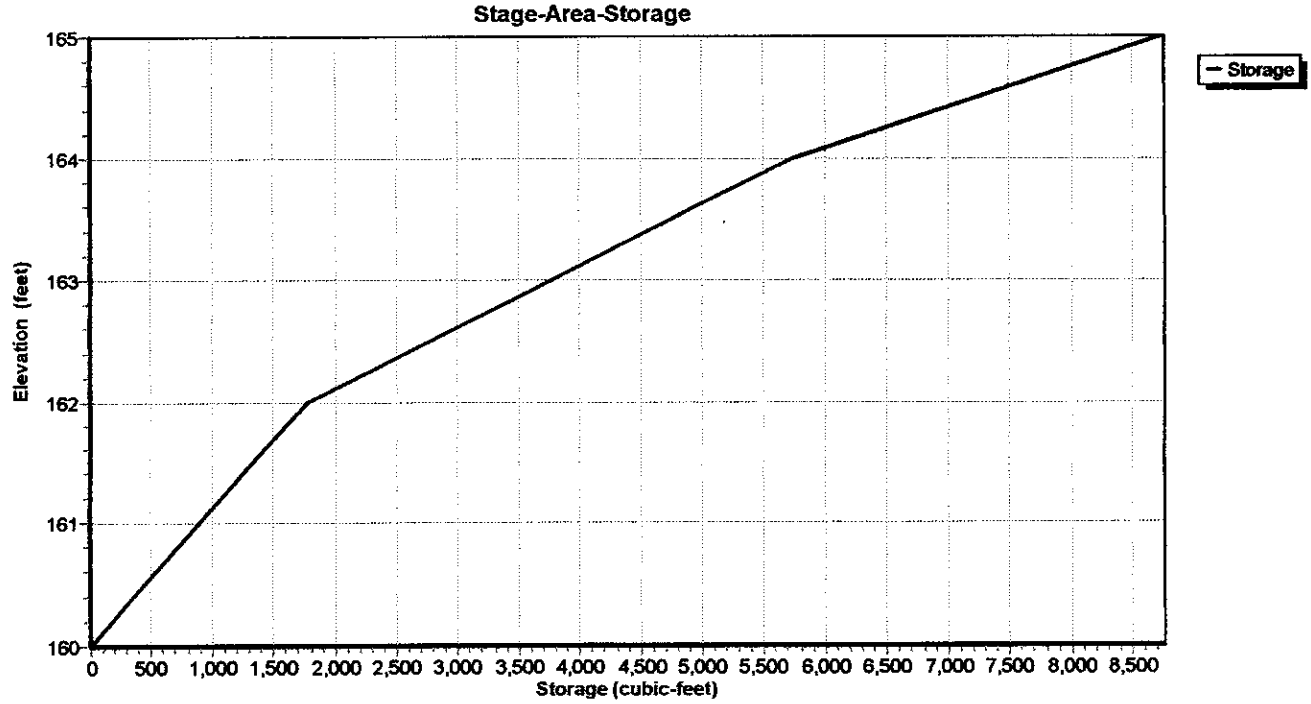
Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Subcatchment 1S:

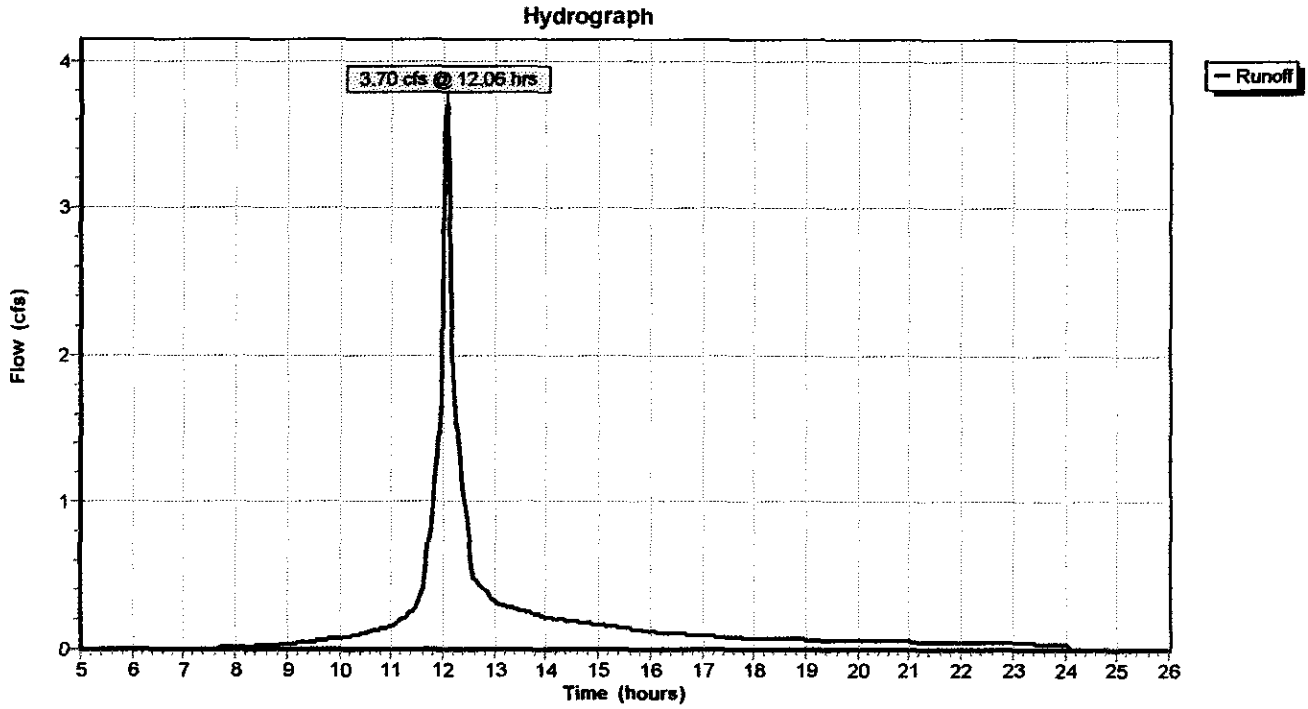
Runoff = 3.70 cfs @ 12.06 hrs, Volume= 0.250 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.50"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

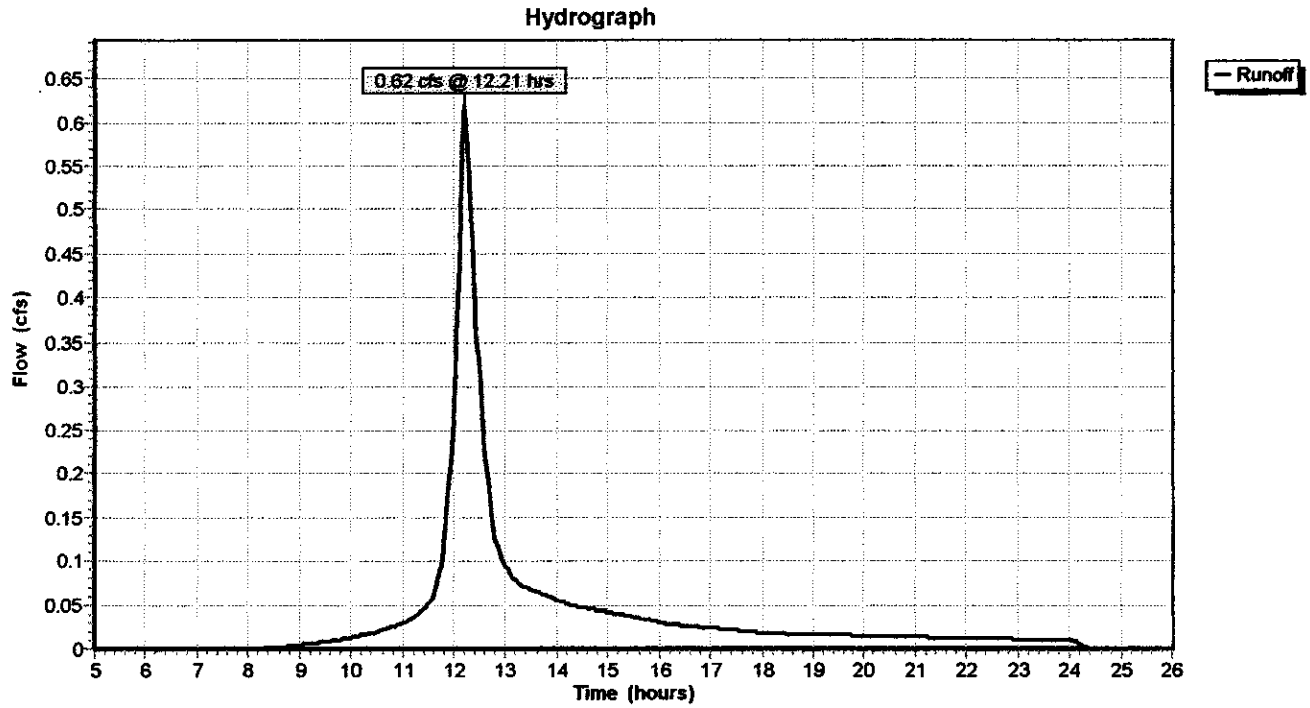
Runoff = 0.62 cfs @ 12.21 hrs, Volume= 0.058 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.50"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

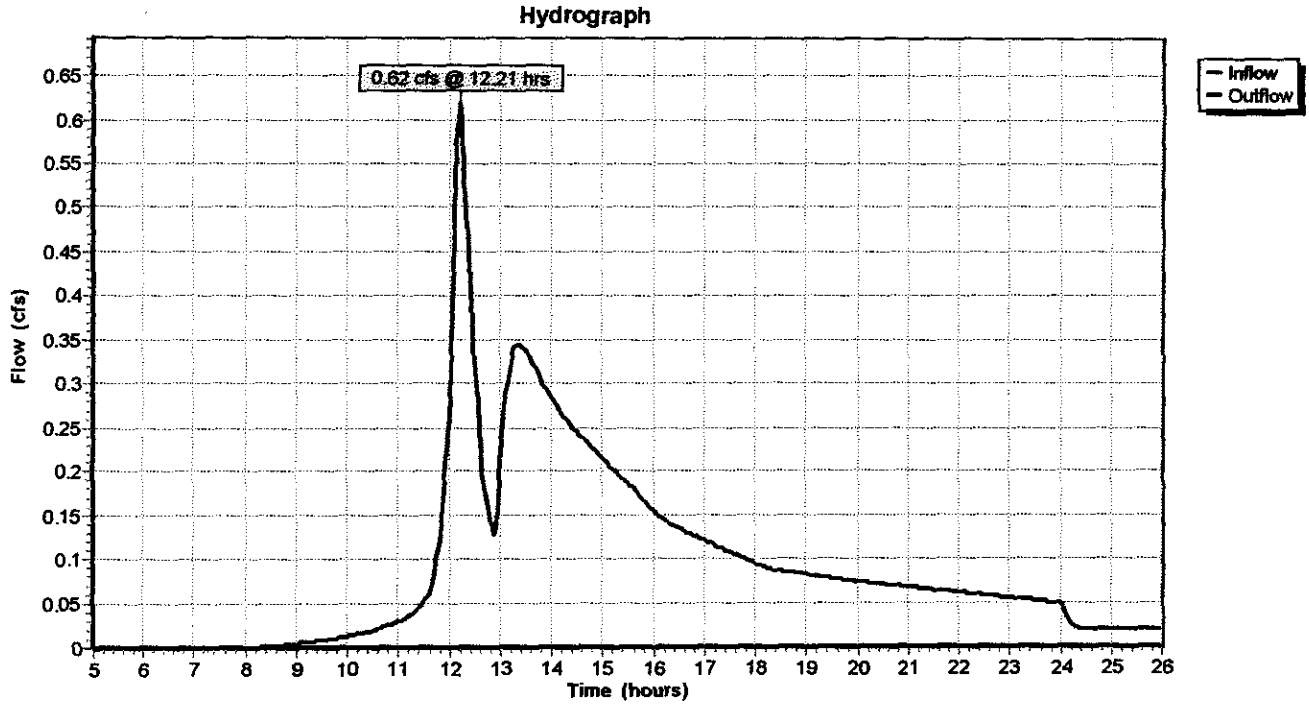


Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.790 ac, Inflow Depth = 1.04"
Inflow = 0.62 cfs @ 12.21 hrs, Volume= 0.155 af
Outflow = 0.62 cfs @ 12.21 hrs, Volume= 0.155 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32



Pond I-2 (Infiltration Basin):

Inflow Area = 1.430 ac, Inflow Depth = 2.10"
Inflow = 3.70 cfs @ 12.06 hrs, Volume= 0.250 af
Outflow = 0.27 cfs @ 13.40 hrs, Volume= 0.097 af, Atten= 93%, Lag= 80.2 min
Primary = 0.27 cfs @ 13.40 hrs, Volume= 0.097 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

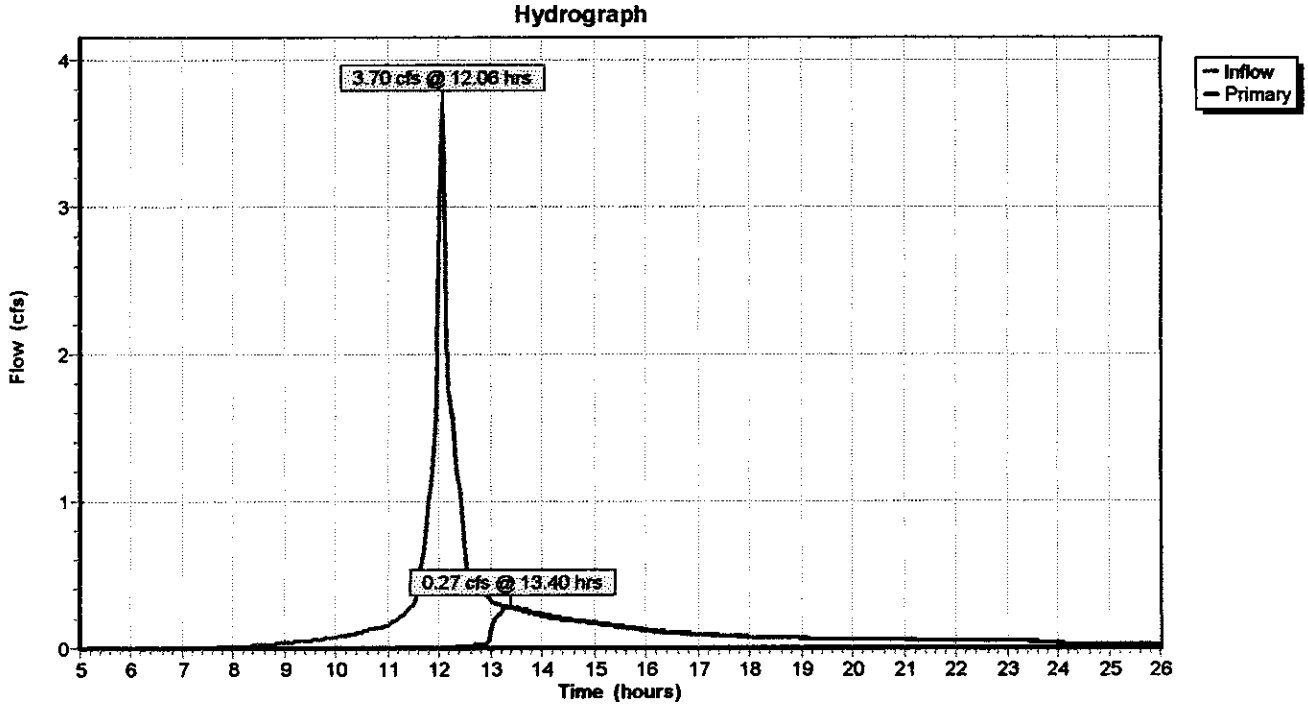
Peak Elev= 164.40' Storage= 6,959 cf
Plug-Flow detention time= 319.8 min calculated for 0.097 af (39% of inflow)

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	0	0
162.00	1,769	1,769
164.00	3,977	5,746
165.00	3,002	8,748

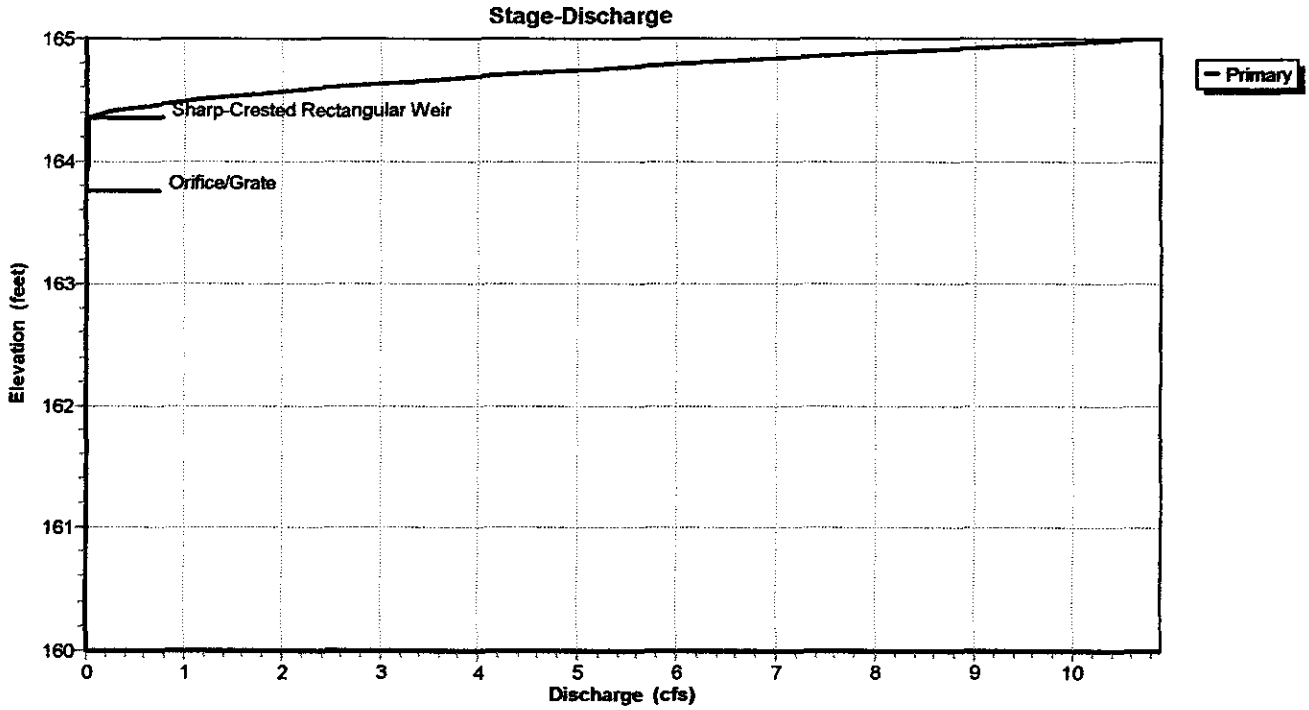
Primary OutFlow Max=0.27 cfs @ 13.40 hrs HW=164.40' (Free Discharge)
└**1=Orifice/Grate** (Controls 0.02 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.25 cfs)

#	Routing	Invert	Outlet Devices
1	Primary	163.75'	**1.0" Vert. Orifice/Grate** C= 0.600
2	Primary	164.35'	**6.0' long x 1.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)

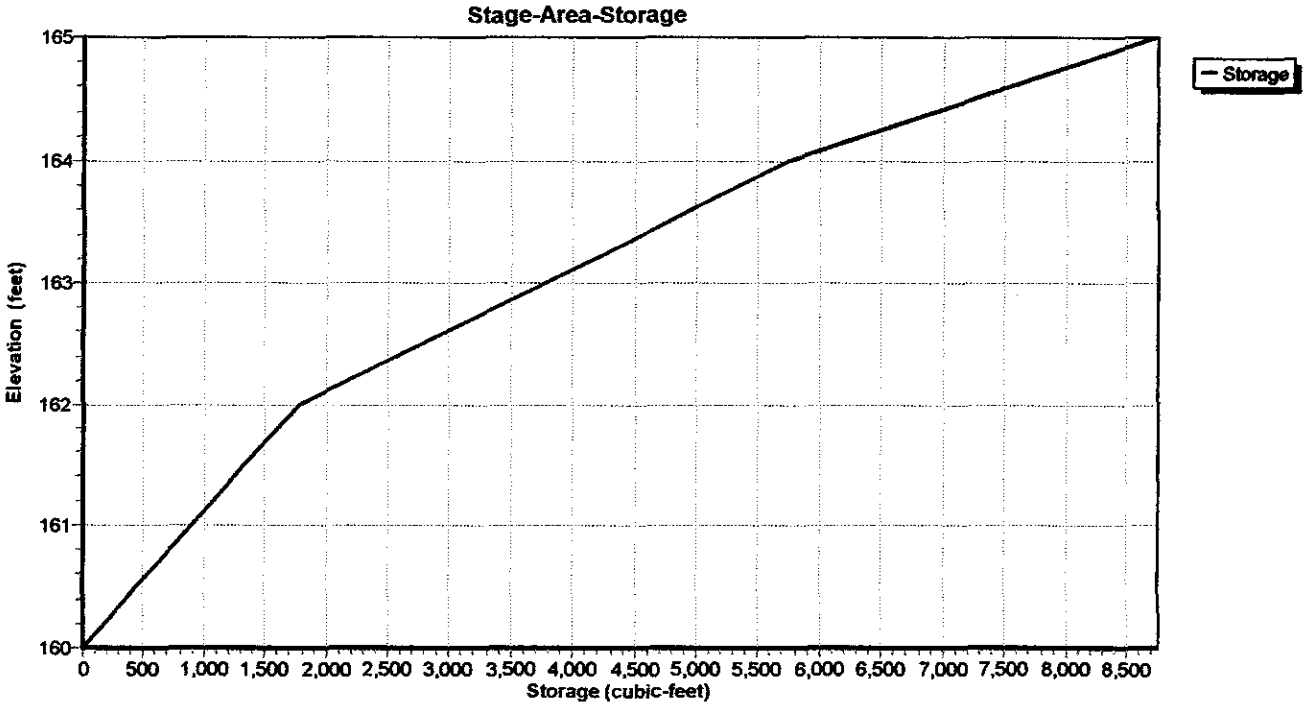
Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Subcatchment 1S:

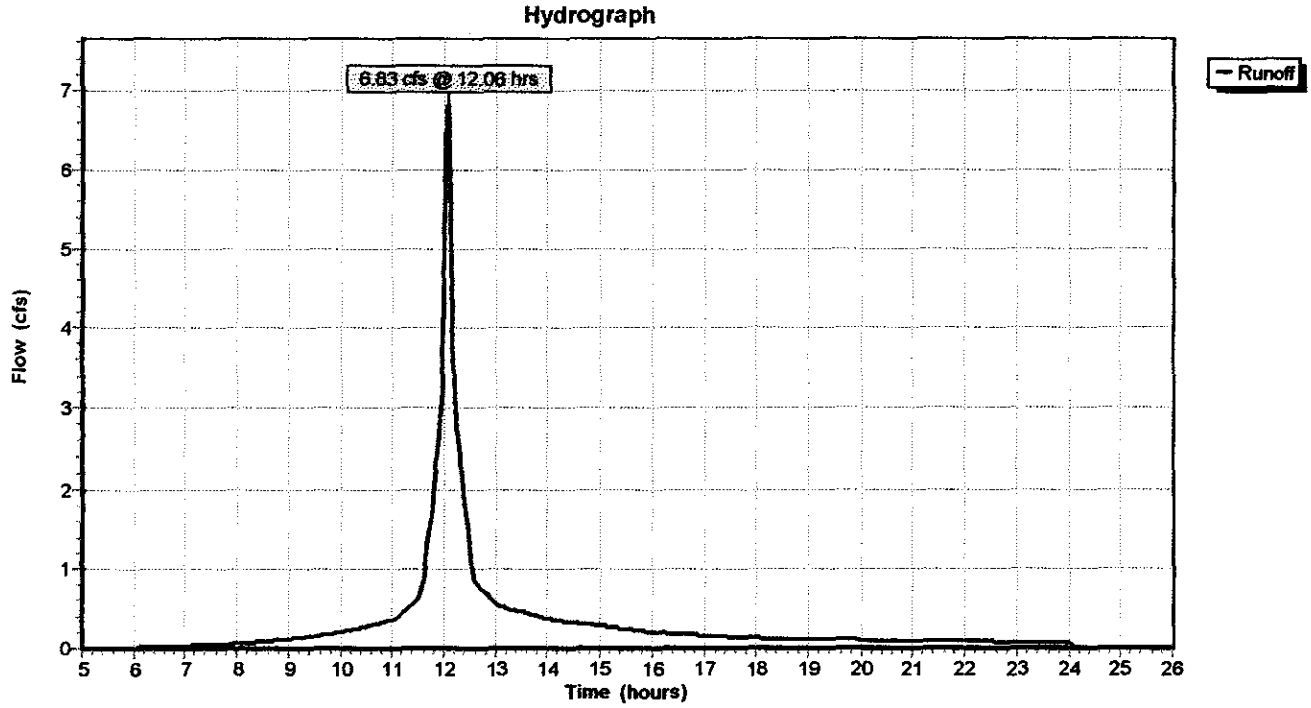
Runoff = 6.83 cfs @ 12.06 hrs, Volume= 0.469 af, Depth= 3.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.50"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

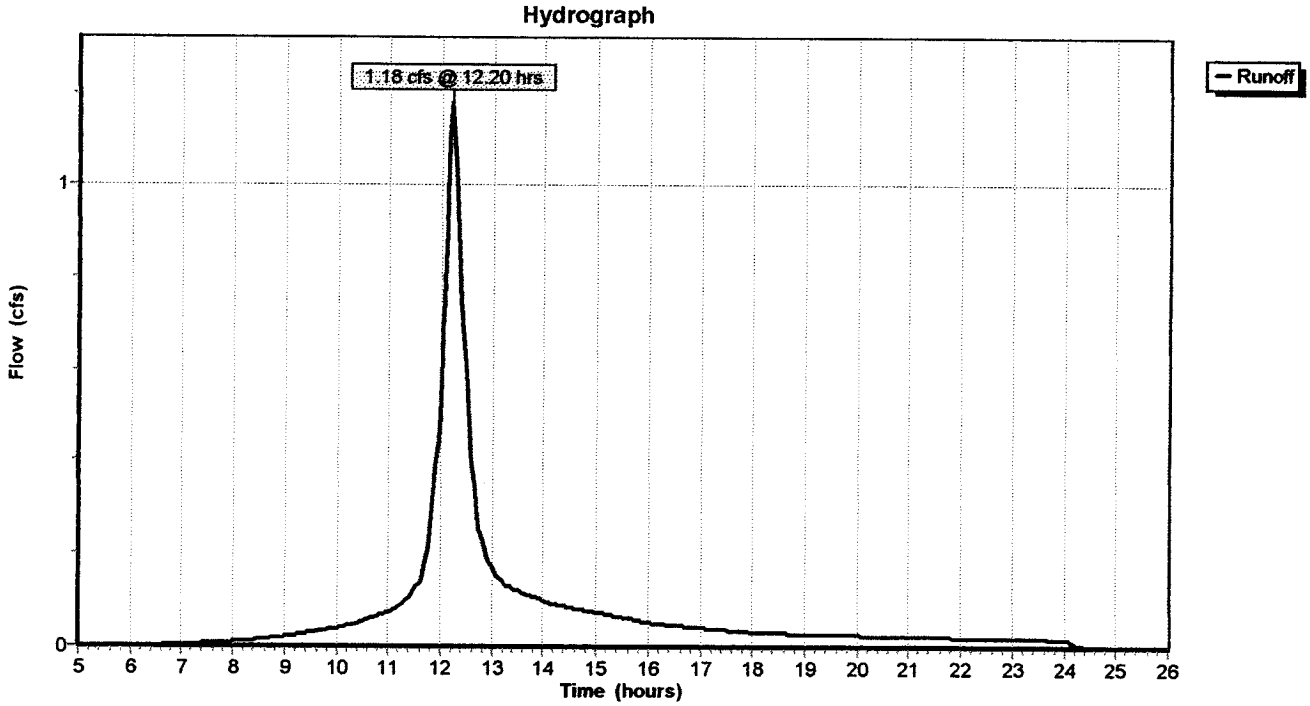
Runoff = 1.18 cfs @ 12.20 hrs, Volume= 0.112 af, Depth= 3.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.50"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

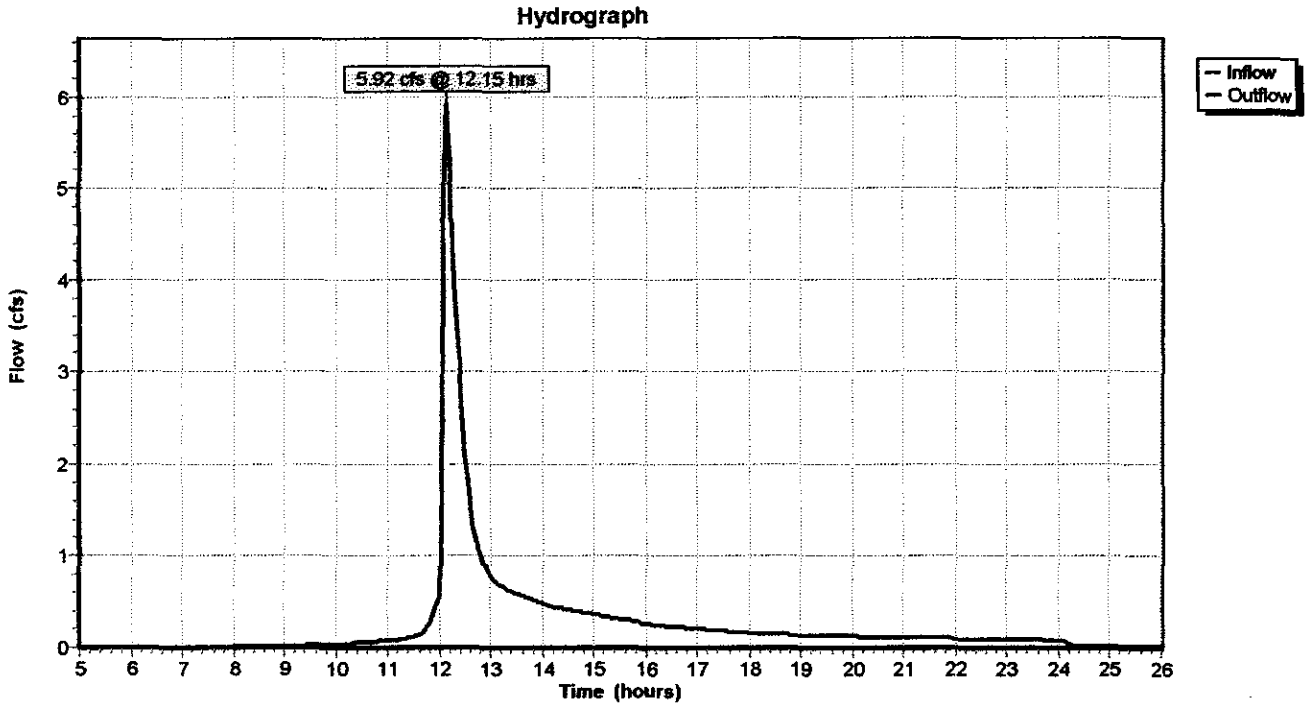


Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.790 ac, Inflow Depth = 2.87"
Inflow = 5.92 cfs @ 12.15 hrs, Volume= 0.428 af
Outflow = 5.92 cfs @ 12.15 hrs, Volume= 0.428 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32



Pond I-2 (Infiltration Basin):

Inflow Area = 1.430 ac, Inflow Depth = 3.94"
Inflow = 6.83 cfs @ 12.06 hrs, Volume= 0.469 af
Outflow = 4.83 cfs @ 12.14 hrs, Volume= 0.316 af, Atten= 29%, Lag= 5.0 min
Primary = 4.83 cfs @ 12.14 hrs, Volume= 0.316 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

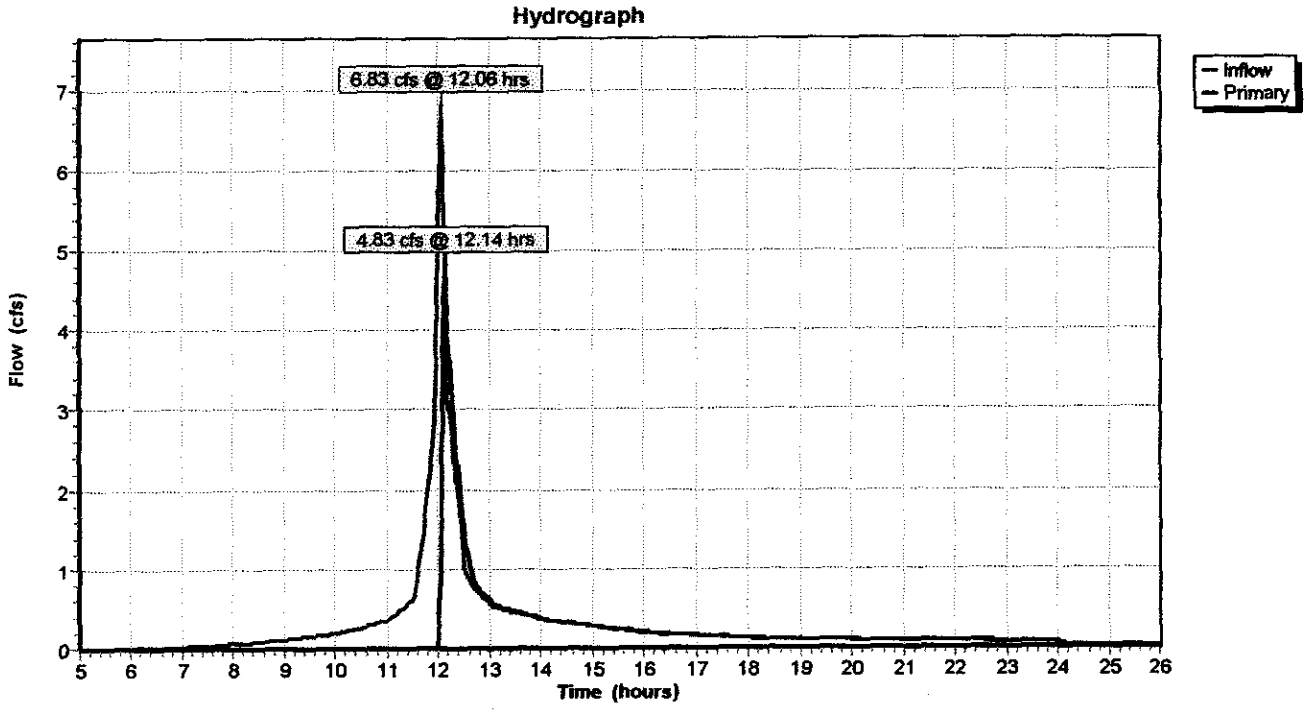
Peak Elev= 164.73' Storage= 7,945 cf
Plug-Flow detention time= 174.8 min calculated for 0.316 af (67% of inflow)

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	0	0
162.00	1,769	1,769
164.00	3,977	5,746
165.00	3,002	8,748

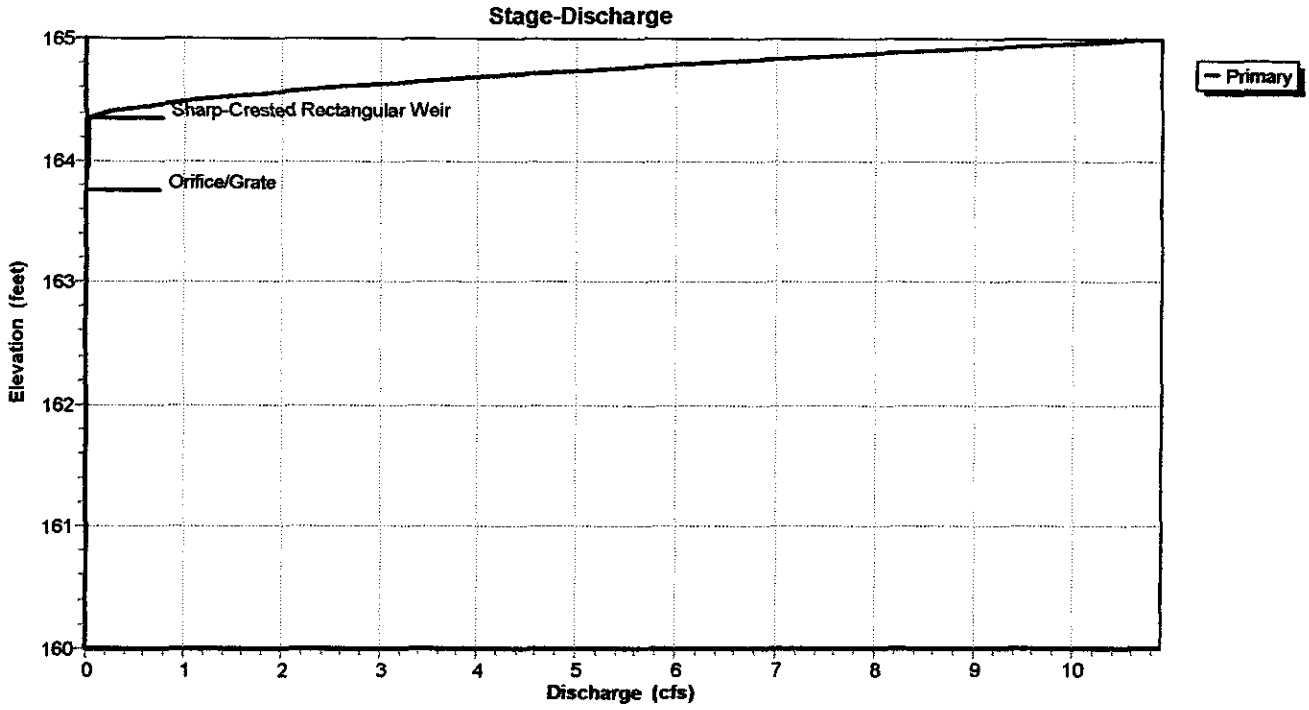
Primary OutFlow Max=4.73 cfs @ 12.14 hrs HW=164.73' (Free Discharge)
└**1=Orifice/Grate** (Controls 0.03 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 4.71 cfs)

#	Routing	Invert	Outlet Devices
1	Primary	163.75'	**1.0" Vert. Orifice/Grate** C= 0.600
2	Primary	164.35'	**6.0' long x 1.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)

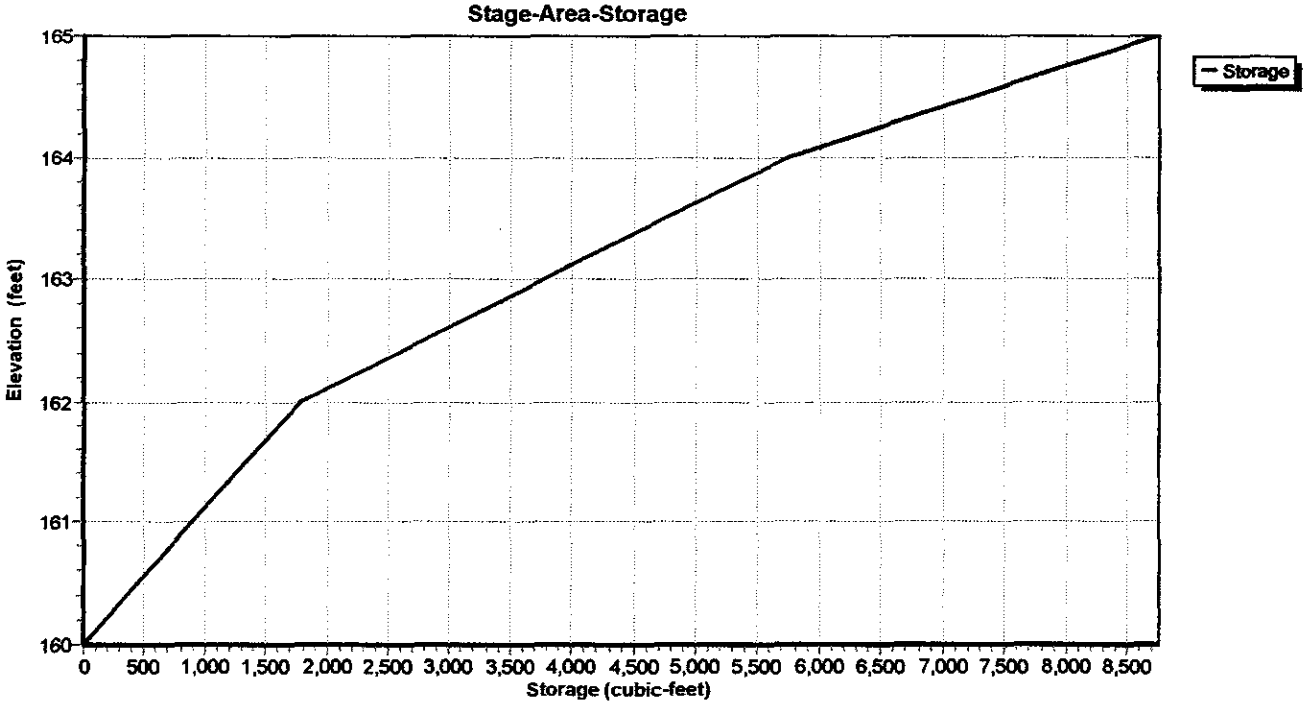
Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Subcatchment 1S:

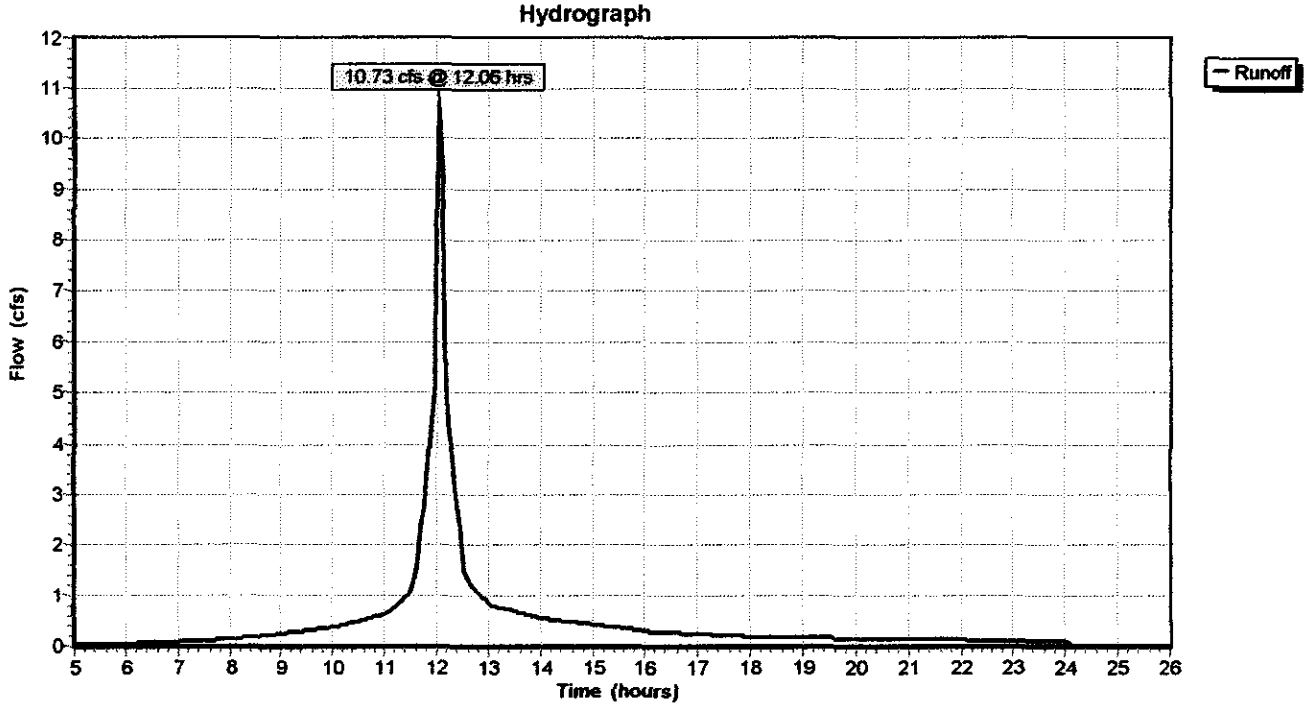
Runoff = 10.73 cfs @ 12.06 hrs, Volume= 0.754 af, Depth= 6.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.980	98	Paved
0.090	98	roofs
0.360	49	50-75% Grass cover, Fair, HSG A
1.430	86	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	11	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
1.2	30	0.3300	0.4		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.8	94	0.0100	2.0		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	90	0.0100	5.3	6.46	**Circular Channel (pipe),** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.6	218	0.0100	5.9	10.50	**Circular Channel (pipe),** Diam= 18.0" Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
3.9	443	Total			

Subcatchment 1S:



Subcatchment 2S:

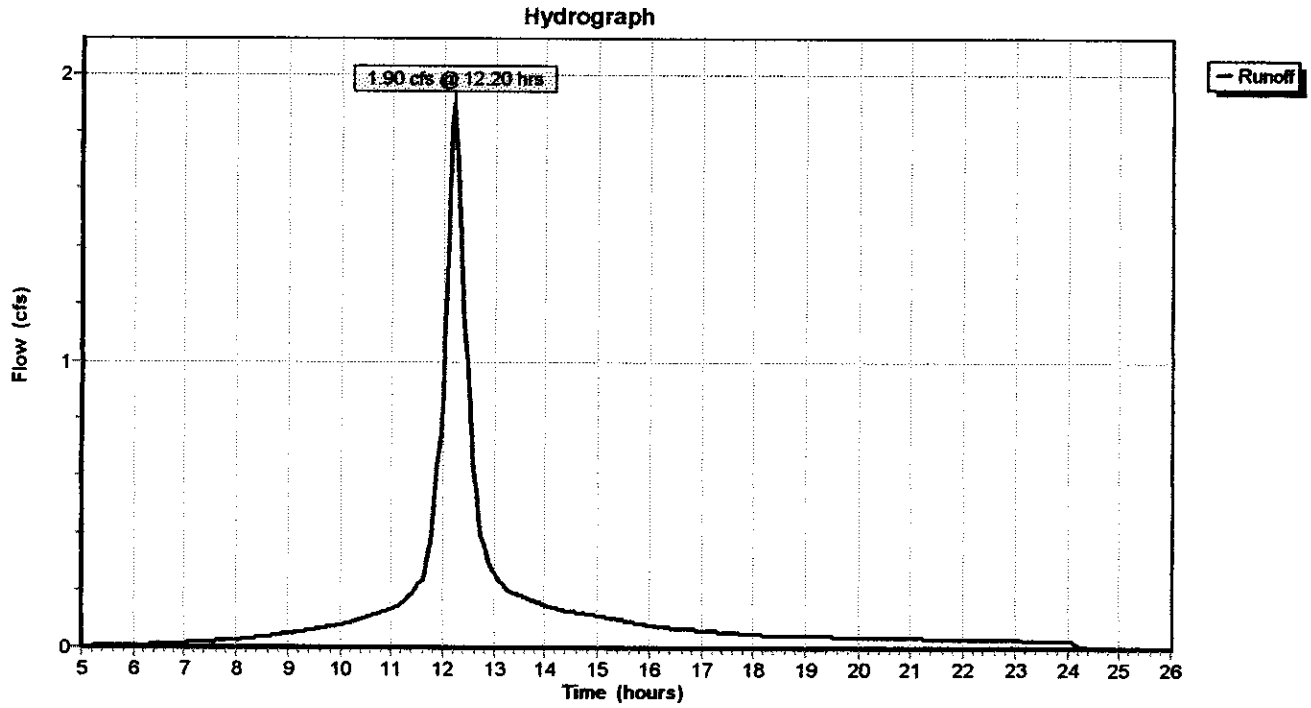
Runoff = 1.90 cfs @ 12.20 hrs, Volume= 0.183 af, Depth= 6.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=8.00"

Area (ac)	CN	Description
0.170	98	Paved
0.090	98	roofs
0.100	49	50-75% Grass cover, Fair, HSG A
0.360	84	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	15	0.0130	0.8		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
4.6	33	0.0130	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
9.5	102	0.0200	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.4	50	0.0200	2.1		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
14.8	200	Total			

Subcatchment 2S:

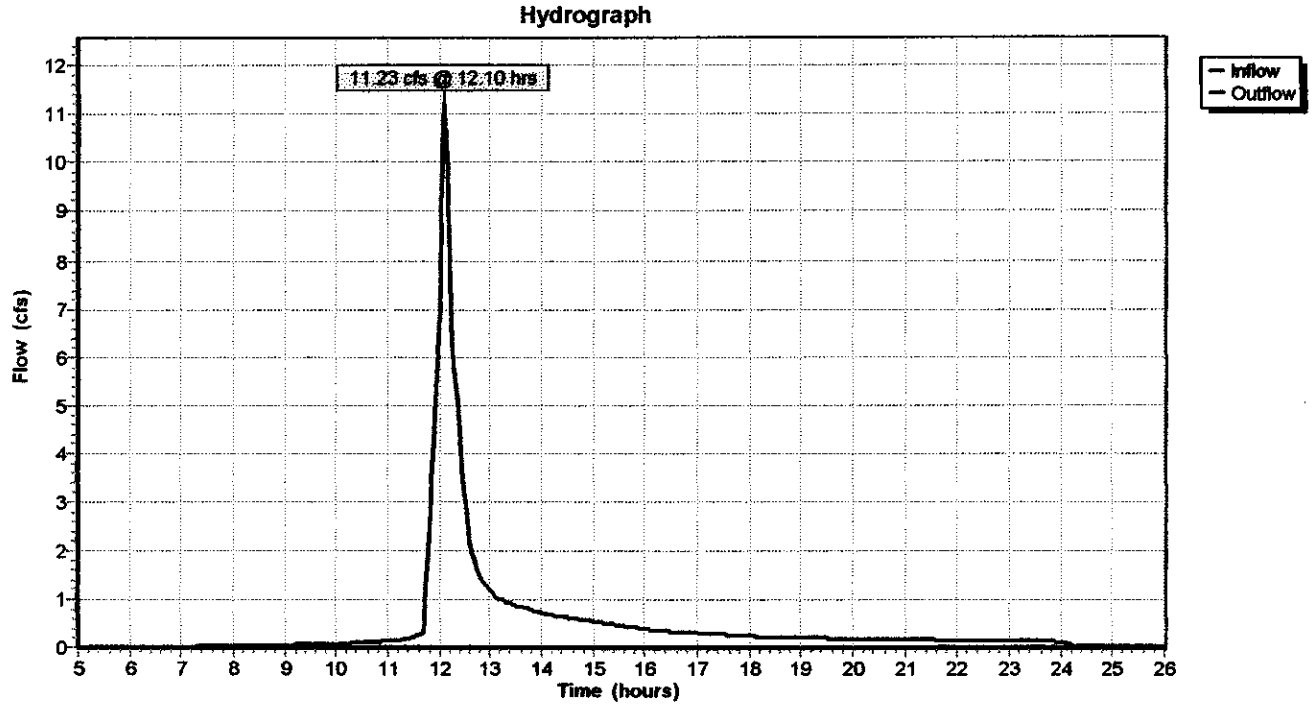


Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32

Inflow Area = 1.790 ac, Inflow Depth = 5.25"
Inflow = 11.23 cfs @ 12.10 hrs, Volume= 0.783 af
Outflow = 11.23 cfs @ 12.10 hrs, Volume= 0.783 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

Reach 1R (CATCH BASIN AT RTE 32): EXISTING CATCH BASIN AT ROUTE 32



Pond I-2 (Infiltration Basin):

Inflow Area = 1.430 ac, Inflow Depth = 6.32"
Inflow = 10.73 cfs @ 12.06 hrs, Volume= 0.754 af
Outflow = 9.78 cfs @ 12.09 hrs, Volume= 0.600 af, Atten= 9%, Lag= 2.2 min
Primary = 9.78 cfs @ 12.09 hrs, Volume= 0.600 af

Routing by Stor-Ind method, Time Span= 5.00-26.00 hrs, dt= 0.05 hrs

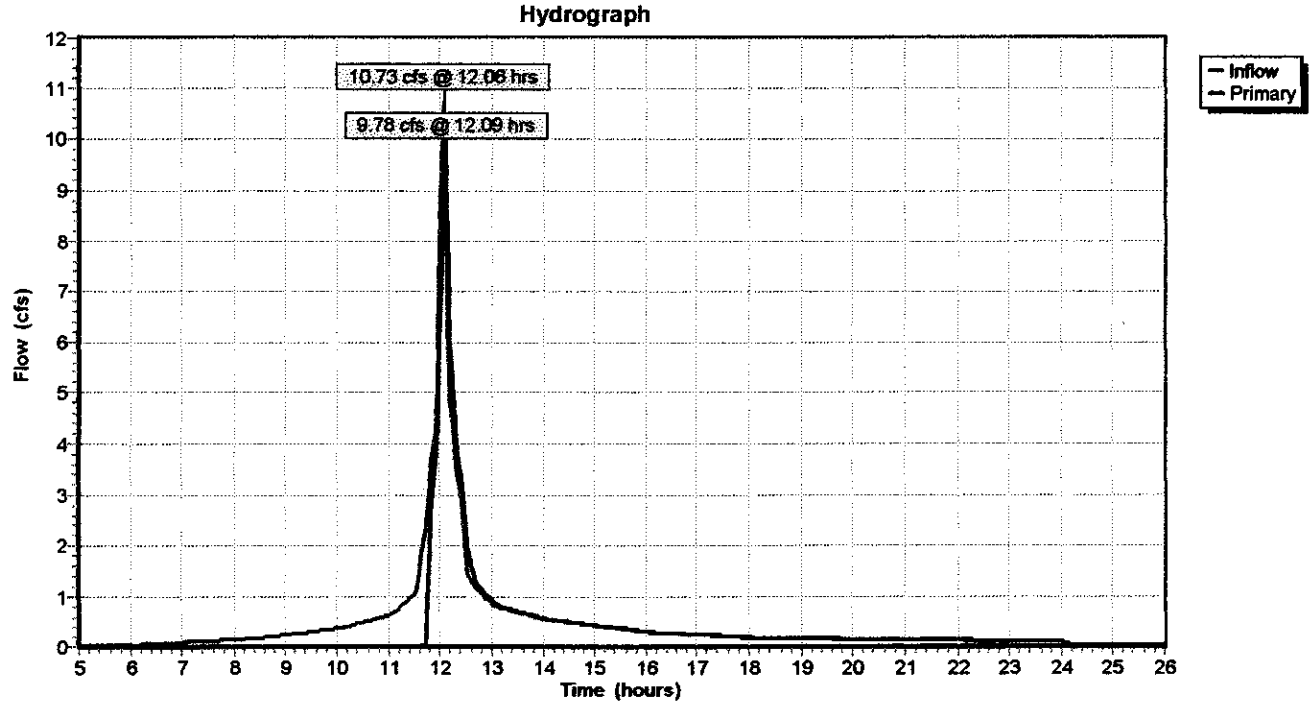
Peak Elev= 164.96' Storage= 8,617 cf
Plug-Flow detention time= 131.3 min calculated for 0.600 af (80% of inflow)

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	0	0
162.00	1,769	1,769
164.00	3,977	5,746
165.00	3,002	8,748

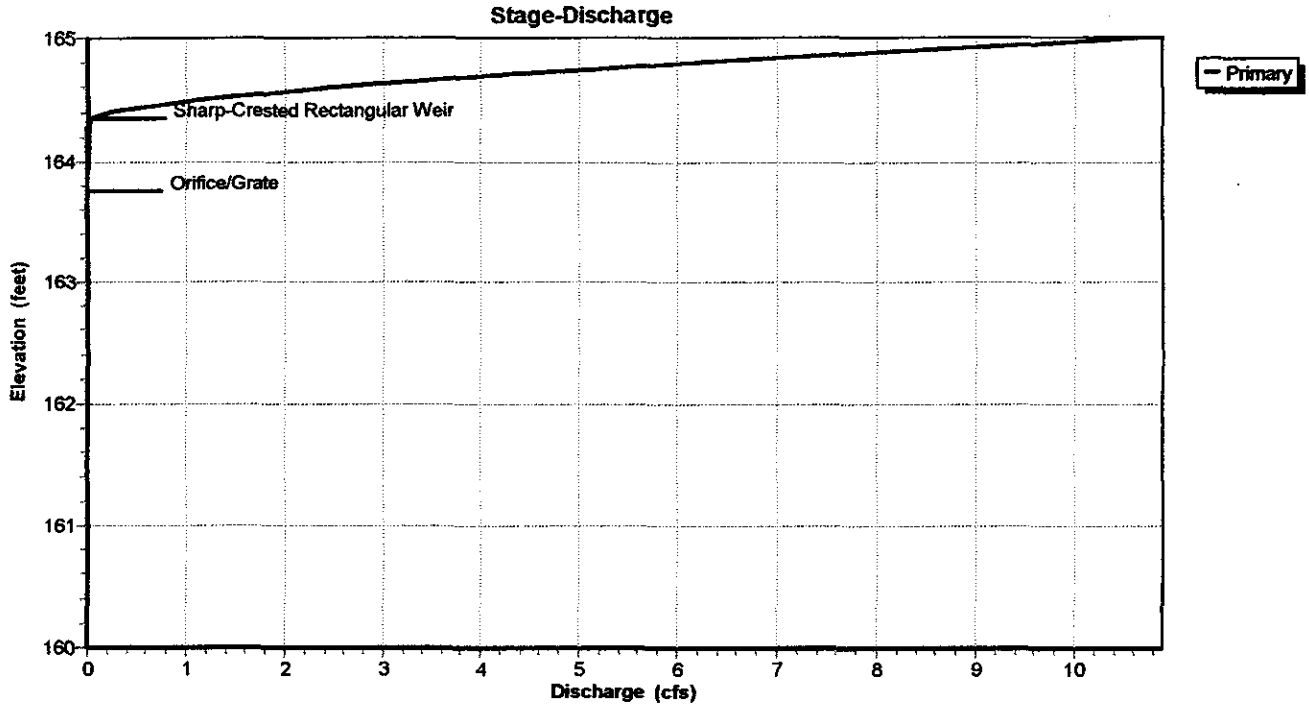
Primary OutFlow Max=9.64 cfs @ 12.09 hrs HW=164.95' (Free Discharge)
└**1=Orifice/Grate** (Controls 0.03 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 9.61 cfs)

#	Routing	Invert	Outlet Devices
1	Primary	163.75'	**1.0" Vert. Orifice/Grate** C= 0.600
2	Primary	164.35'	**6.0' long x 1.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)

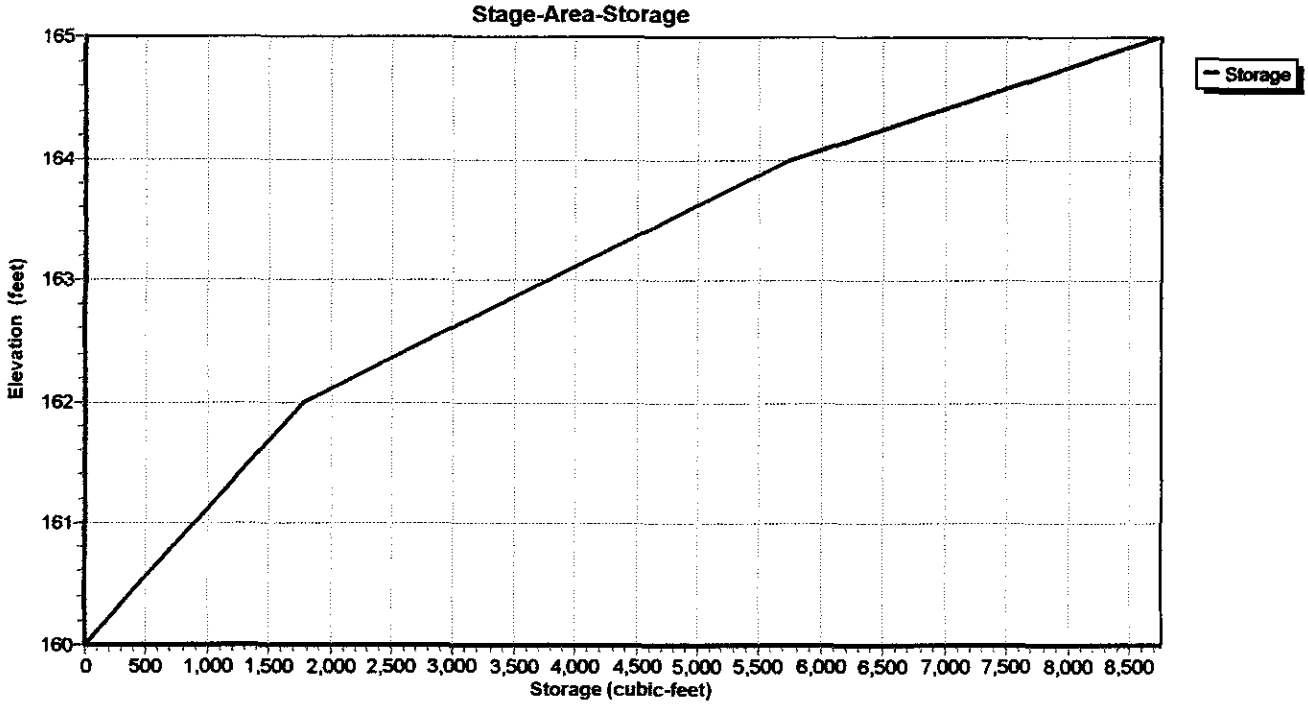
Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



Pond I-2 (Infiltration Basin):



APPENDIX D

DRAINAGE ARE SUBCATCHMENTS "1S"

VOLUME CALCULATION OF WATER QUALITY, STREAM CHANNEL PROTECTION, OVERBANK FLOOD PROTECTION AND EXTREME FLOOD PROTECTION

Water Quality Volume (WQv)

Impervious area (acre)	1.07
Total area (acre)	1.43
Impervious Coverage (I)	74.83 %

Calculation Runoff Coefficient (Rv)

Rv = 0.05+(I)(0.009) = 0.72

Water Quality Volume Calculation (WQv)

WQv = [(P)(Rv/12)(A)]

P (in)	1.2
WQv =	0.10 ac-ft
	4,506.28 cu-ft
	0.103 ac-ft

Average Release Rate

$$\frac{(Cpv)\text{cu-ft}}{24 \text{ hrs} \times 3600 \text{sec/hr}} = \textbf{0.05 cfs}$$

Stream Channel Protection Volume (Cpv)

Q	1.58 in (one year postdeveloped condition)
P	2.90
CN	86
Ia	0.33
Ia/P	0.11
Tc	0.1 hrs
q_u	650 csm/in
Time	24 hrs
q_o/q_i	0.035

$Vs/Vr = 0.683 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$

0.63

Cpv = (Vs/Vr)(Q/12)(A) =

	0.12 ac-ft
	5,207.41 cu-ft
	5,988.52 cfs (15% addition)

0.14 acre-ft

Average Release Rate

$$\frac{\text{(Cpv)cu-ft}}{\text{24 hrs x 3600sec/hr}} = \textbf{0.07 cfs}$$

Overbank Flood Protection (Q_{p10})

$Q_{pre\ 10}$	1.21 cfs
$Q_{pos\ 10}$	7.55 cfs
$Q_{pre\ 10}/Q_{pos\ 10}$	0.16
CN	86
Vs/Vr =	0.50
Vr =	25,308.00 cu-ft
Vs =	12,654.00 cu-ft
	14,552.10 cfs (15% addition)
	0.33 acre-ft

Extreme Flood Protection Volume (Q_f)

$Q_{pre\ 100}$	2.02 cfs
$Q_{pos\ 100}$	11.91 cfs
$Q_{pre\ 100}/Q_{pos\ 100}$	0.17
CN	86
Vs/Vr =	0.50
Vr =	40,772.00 cu-ft
Vs =	20,386.00 cu-ft
	23,443.90 cfs (15% addition)
	0.54 acre-ft

The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation-Hydrology". The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \qquad \text{[Eq. 10.8]}$$

where

q_p = peak discharge (cfs);

q_u = unit peak discharge (csm/in);

A_m = drainage area (mi^2);

Q = runoff (in); and

F_p = pond and swamp adjustment factor.

The input requirements for the Graphical method are as follows:

(1) T_c (hr),

(2) drainage area (mi^2),

(3) appropriate rainfall distribution (I, IA, II, or III),

(4) 24-hour rainfall (in), and

(5) CN.

If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak Discharge Computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from Exhibit 10.1 at the end of this chapter. CN and total runoff (Q) for the watershed were computed earlier. The CN is used to determine the initial abstraction, (I_a) from Table 10.4 on page 10.24. I_a/P is then computed.

If the computed I_a/P ratio is outside the range shown in Figures 10.16 and 10.17 on pages 10.28 and 10.29 respectively for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 10.13 on page 10.24 illustrates the sensitivity of I_a/P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from Figures 10.16 and 10.17 by using T_c, rainfall distribution type, and I_a/P ratio. The pond and swamp adjustment factor is obtained from Table 10.5 on page 10.25 (rounded to the nearest Table value). Use Worksheet 4, Figure 10.14 on page 10.26, to aid in computing the peak discharge using the Graphical method.

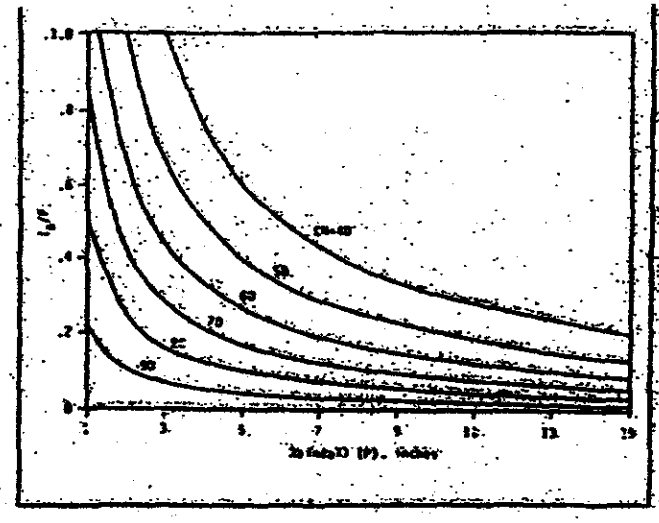


Table 10.4 - I_a Values for Runoff Curve Numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.637	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Figure 8.5 Detention Time vs. Discharge Ratios (Source: MDE, 2000)

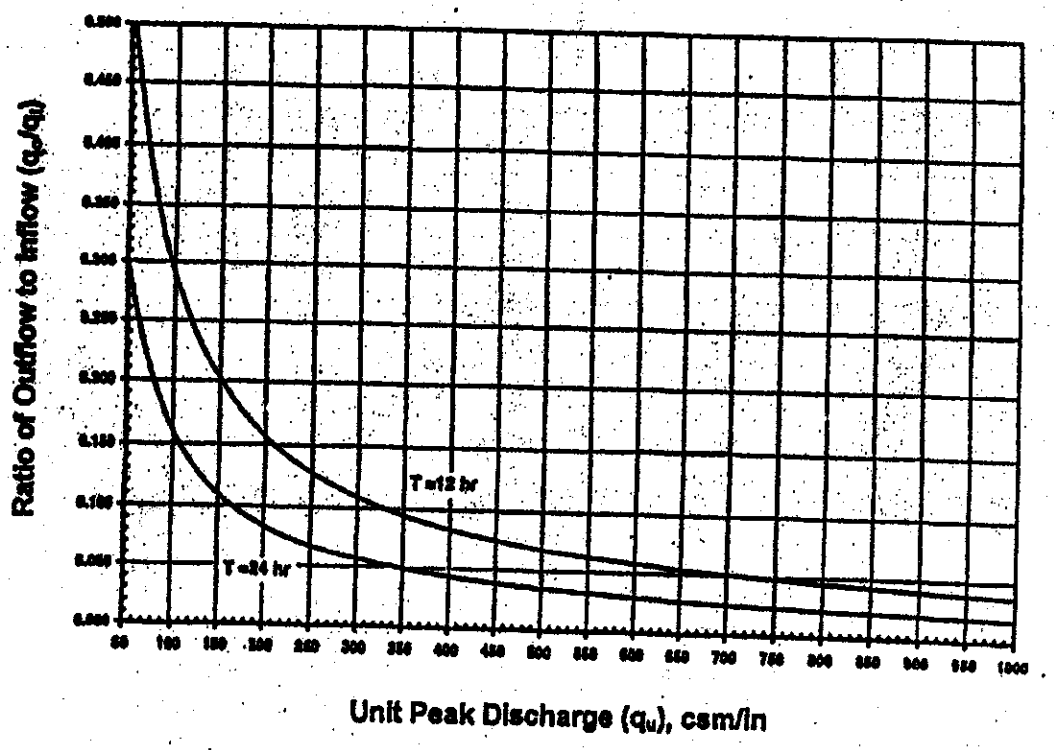
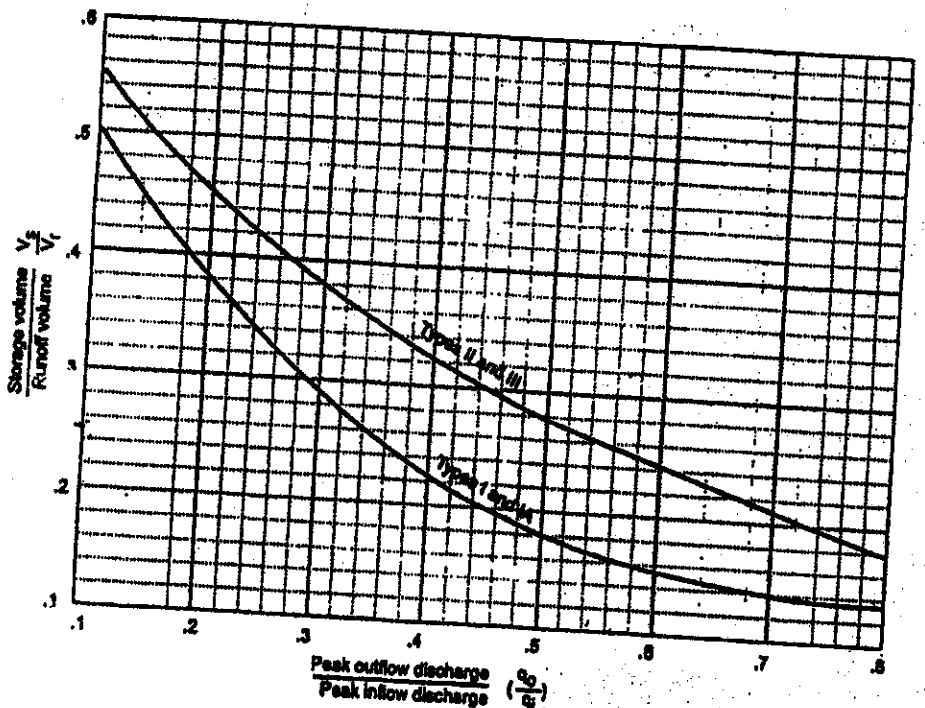
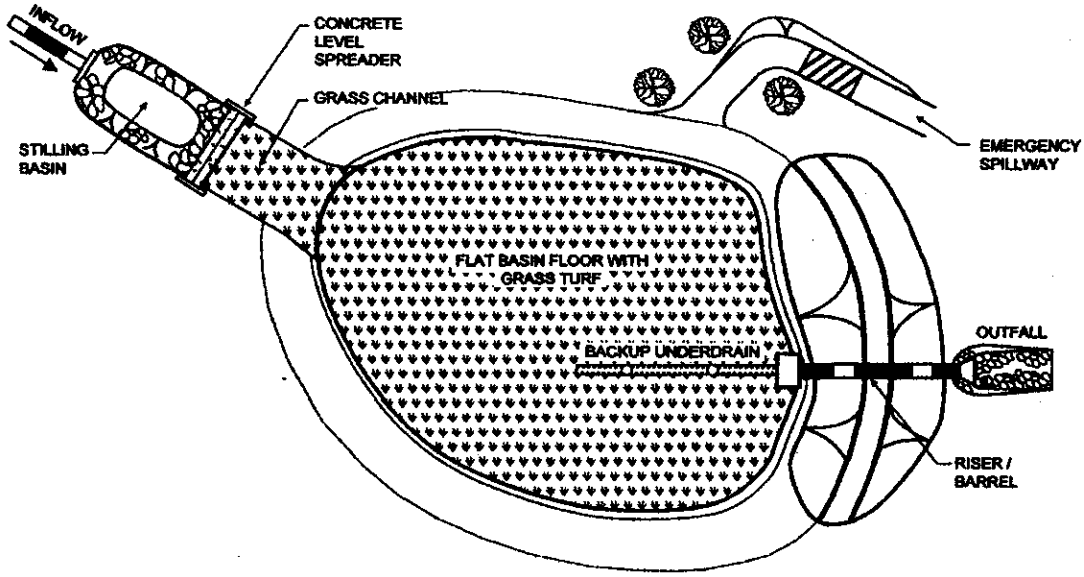


Figure 8.6 Approximate Detention Basin Routing for Rainfall Types I, IA, II, and III
Source: TR-55, 1986

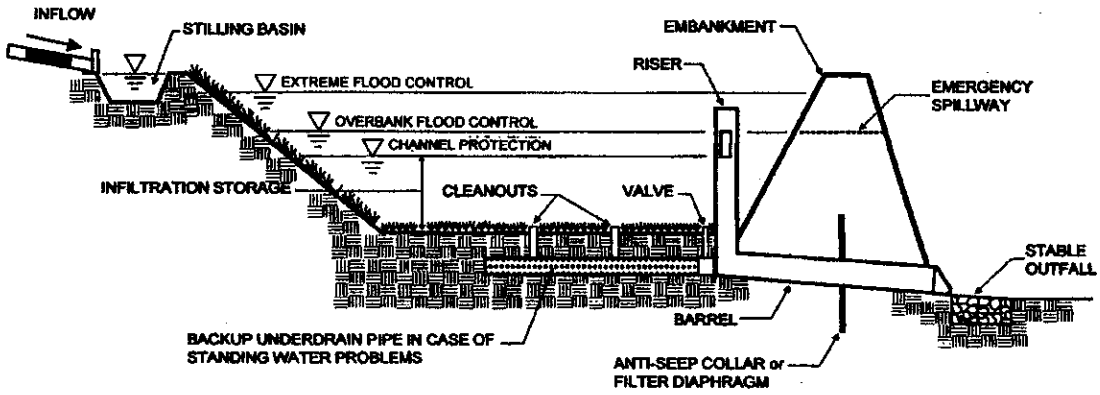


While the TR-55 short-cut method reports to incremental

Figure 6.12 Infiltration Basin (I-2)



PLAN VIEW



PROFILE

6.3.1 Feasibility

Required Elements

- To be suitable for infiltration, underlying soils shall have an infiltration rate (fc) of at least 0.5 inches per hour, as initially determined from NRCS soil textural classification, and subsequently confirmed by field geotechnical tests (see Appendix D). The minimum geotechnical testing is one test hole per 5000 sf, with a minimum of two borings per facility (taken within the proposed limits of the facility).
- Soils shall also have a clay content of less than 20% and a silt/clay content of less than 40%.
- Infiltration practices cannot be located on areas with natural slopes greater than 15%.
- Infiltration practices cannot be located in fill soils, except the top quarter of an infiltration trench or dry well.
- To protect groundwater from possible contamination, runoff from designated hotspot land uses or activities must not be directed to a formal infiltration facility. In cases where this goal is impossible (e.g., where the storm drain system leads to a large recharge facility designed for flood control), redundant pretreatment must be provided by applying two of the practices listed in Table 5.1 in series, both of which are sized to treat the entire WQ_v.
- The bottom of the infiltration facility shall be separated by at least three feet vertically from the seasonally high water table or bedrock layer, as documented by on-site soil testing. (Four feet in sole source aquifers).
- Infiltration facilities shall be located at least 100 feet horizontally from any water supply well.
- Infiltration practices cannot be placed in locations that cause water problems to downgradient properties. Infiltration trenches and basins shall be setback 25 feet downgradient from structures and septic systems. Dry wells shall be separated a minimum of 10 feet from structures.

Design Guidance

- The maximum contributing area to infiltration basins or trenches should generally be less than five acres. The infiltration basin can theoretically receive runoff from larger areas, provided that the soil is highly permeable (i.e., greater than 5.0 inches per hour). (See Appendix L for erosive velocities of grass and soil).
- The maximum drainage area to dry wells should generally be smaller than one acre, and should include rooftop runoff only.

6.3.2 Conveyance

Required Elements

- The overland flow path of surface runoff exceeding the capacity of the infiltration system shall be evaluated to preclude erosive concentrated flow during the overbank events. If computed flow velocities exceed erosive velocities (3.5 to 5.0 fps), an overflow channel shall be provided to a stabilized watercourse. (See Appendix L for erosive velocities of grass and soil).
- All infiltration systems shall be designed to fully de-water the entire WQ_v within 48 hours after the storm event.
- If runoff is delivered by a storm drain pipe or along the main conveyance system, the infiltration practice must be designed as an off-line practice (see Appendix K for a detail), except when used as a regional flood control practice.

Design Guidance

- For infiltration basins and trenches, adequate stormwater outfalls should be provided for the overflow associated with the 10-year design storm event (non-erosive velocities on the down-slope
- For dry wells, all flows that exceed the capacity of the dry well should be passed through the surcharge pipe.

6.3.3 Pretreatment

Required Elements

- A minimum pretreatment volume of 25% of the WQ_v must be provided prior to entry to an infiltration facility, and can be provided in the form of a sedimentation basin, sump pit, grass channel, plunge pool or other measure.
- If the f_c for the underlying soils is greater than 2.00 inches per hour, a minimum pretreatment volume of 50% of the WQ_v must be provided.
- If the f_c for the underlying soils is greater than 5.00 inches per hour, 100% of the WQ_v shall be pre-treated prior to entry into an infiltration facility.
- Exit velocities from pretreatment chambers shall be non-erosive (3.5 to 5.0 fps) during the two-year design storm). (See Appendix L for erosive velocities of grass and soil).

Pretreatment Techniques to Prevent Clogging

Infiltration basins or trenches can have redundant methods to ensure the long-term integrity of the infiltration rate. The following techniques are pretreatment options for infiltration practices:

- Grass channel (Maximum velocity of 1 fps for water quality flow. See the Fact Sheet on page 5-10 for more detailed design information.)
- Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)
- Bottom sand layer (for I-1)
- Upper sand layer (for I-1; 6" minimum with filter fabric at sand/gravel interface)
- Use of washed bank run gravel as aggregate
- Alternatively, a pre-treatment settling chamber may be provided and sized to capture the pretreatment volume. Use the method prescribed in section 6.4.3 (i.e., the Camp-Hazen equation) to size the chamber.
- Plunge Pool
- An underground trap with a permanent pool between the downspout and the dry well (I-3)

Design Guidance

- The sides of infiltration trenches and dry wells should be lined with an acceptable filter fabric that prevents soil piping.
- In infiltration trench designs, incorporate a fine gravel or sand layer above the coarse gravel treatment reservoir to serve as a filter layer.

6.3.4 Treatment

Required Elements

- Infiltration practices shall be designed to exfiltrate the entire WQ_v through the floor of each practice (sides are not considered in sizing).
- The construction sequence and specifications for each infiltration practice shall be precisely followed. Experience has shown that the longevity of infiltration practices is strongly influenced by the care taken during construction
- Calculate the surface area of infiltration trenches as:

$$A_p = V_W / (nd_t)$$

Where:

A_p = surface area (sf)
V_W = design volume (e.g., WQ_V) (ft^3)
n = porosity (assume 0.4)
d_t = trench depth (maximum of four feet, and separated at least three feet from seasonally high groundwater) (ft)

- Calculate the approximate bottom area of infiltration basins using the following equation:

$$A = V_w/d_b$$

Where:

A = surface area of the basin (ft^2)
d_b = depth of the basin (ft)

Note that in trapezoidal basins, this area should first be used to approximate the area at the bottom of the basin, but can later be modified to account for additional storage provided above side slopes.

Design Guidance

- Infiltration practices are best used in conjunction with other practices, and downstream detention is often needed to meet the Cp_v and Q_p sizing criteria.
- A porosity value (V_v/V_t) of 0.4 can be used to design stone reservoirs for infiltration practices.

The bottom of the stone reservoir should be completely flat so that infiltrated runoff will be able to infiltrate through the entire surface.

6.3.5 Landscaping

Required Elements

- Upstream construction shall be completed and stabilized before connection to a downstream infiltration facility. A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility.
- Infiltration trenches shall not be constructed until all of the contributing drainage area has been completely stabilized.

Design Guidance

- Mow upland and adjacent areas, and seed bare areas.

6.3.6 Maintenance

Required Elements

- Infiltration practices shall never serve as a sediment control device during site construction phase. In addition, the Erosion and Sediment Control plan for the site shall clearly indicate how sediment will be prevented from entering an infiltration facility. Normally, the use of diversion berms around the perimeter of the infiltration practice, along with immediate vegetative stabilization and/or mulching can achieve this goal.
- An observation well shall be installed in every infiltration trench and dry well, consisting of an anchored six- inch diameter perforated PVC pipe with a lockable cap installed flush with the ground surface.
- Direct access shall be provided to infiltration practices for maintenance and rehabilitation. If a stone reservoir or perforated pipe is used to temporarily store runoff prior to infiltration, the practice shall not be covered by an impermeable surface.

Design Guidance

- OSHA trench safety standards should be consulted if the infiltration trench will be excavated more than five feet.
- Infiltration designs should include dewatering methods in the event of failure. Dewatering can be accomplished with underdrain pipe systems that accommodate drawdown.

6.3.7 Cold Climate Design Considerations

Because of additional challenges in cold climates, infiltration SMPs need design modifications to function properly. These modifications address the following problems:

- Reduced infiltration into frozen soils
- Chlorides

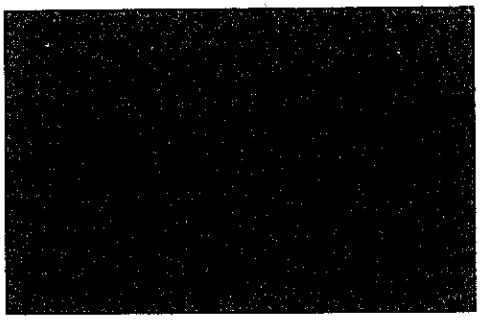
Reduced Infiltration

- Draining the ground beneath an infiltration system with an underdrain can increase cold weather soil infiltration.
- Another alternative is to divide the treatment volume between an infiltration SMP and another SMP to provide some treatment during the winter months.
- A seasonally operated infiltration/detention facility combines several techniques to improve the performance of infiltration SMPs in cold climates. Two features, the underdrain system and level control valves, are useful in cold climates. The level control and valves are opened at the beginning of the winter season and the soil is allowed to drain. As the snow begins to melt in the spring, the valves are closed, and the snowmelt is infiltrated until the capacity of the soil is reached. After this point, the facility acts as a detention facility, providing storage for particles to settle (Figure 6.14)

Chlorides

- Consider diverting snowmelt runoff past infiltration devices, especially in regions where chloride concentration in groundwater is a concern.
- Incorporate mulch into infiltration basin soil to mitigate problems with soil fertility.
- The selection of upland landscaping materials should include salt-tolerant grasses where appropriate.

Infiltration Practices



Description: Excavated trench or basin used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the basin or trench.

Design Options:
Infiltration Trench (I-1), Shallow Infiltration Basin (I-2), Dry Well (I-3)

KEY CONSIDERATIONS

FEASIBILITY

- Minimum soil infiltration rate of 0.5 inches per hour
- Soils less than 20% clay, and 40% silt/clay, and no fill soils.
- Natural slope less than 15%
- Cannot accept hotspot runoff, except under the conditions outlined in Section 6.3.1.
- Separation from groundwater table of at least three feet (four feet in sole source aquifers).
- 25' separation from structures for I-1 and I-2; 10' for I-3.

CONVEYANCE

- Flows exiting the practice must be non-erosive (3.5 to 5.0 fps)
- Maximum dewatering time of 48 hours.
- Design off-line if stormwater is conveyed to the practice by a storm drain pipe.

PRETREATMENT

- Pretreatment of 25% of the WQv at all sites.
- 50% pretreatment if fc >2.0 inches/hour.
- 100% pretreatment in areas with fc >5.0 inches/hour.
- Exit velocities from pretreatment must be non-erosive for the 2-year storm.

TREATMENT

- Water quality volume designed to exfiltrate through the floor of the practice.
- Construction sequence to maximize practice life.
- Trench depth shall be less than four feet (I-2 and I-3).
- Follow the methodologies in Chapter 6 to size practices.

LANDSCAPING

- Upstream area shall be completely stabilized before flow is directed to the practice.

MAINTENANCE REQUIREMENTS

- Never serves as a sediment control device
- Observation well shall be installed in every trench, (6" PVC pipe, with a lockable cap)
- Provide direct maintenance access.

STORMWATER MANAGEMENT SUITABILITY

- [X] **Water Quality**
- [ ] **Channel Protection**
- [ ] **Overbank Flood Protection**
- [ ] **Extreme Flood Protection**

Accepts Hotspot Runoff: *No*

IMPLEMENTATION CONSIDERATIONS

- [H] **Capital Cost**
- [H] **Maintenance Burden**

Residential Subdivision Use: Yes

High Density/Ultra-Urban: *Yes*

Drainage Area: *10 acres max.*

Soils: *Pervious soils required (0.5 in/hr or greater)*

Other Considerations:

- *Must not be placed under pavement or concrete*

Key: **L**=Low **M**=Moderate **H**=High

General Notes Pertinent to All Testing

1. For infiltration practices, a minimum field infiltration rate (f_c) of 0.5 inches per hour is required; areas yielding a lower rate preclude these practices. If the minimum f_c exceeds two inches per hour, half of the WQ_v must be treated by an upstream SMP that does allow infiltration. For F-1 and F-6 practices, no minimum infiltration rate is required if these facilities are designed with a "day-lighting" underdrain system; otherwise these facilities require a 0.5 inch per hour rate.

2. Number of required borings is based on the size of the proposed facility. Testing is done in two phases, (1) Initial Feasibility, and (2) Concept Design Testing.

3. Testing is to be conducted by a qualified professional. This professional shall either be a registered professional engineer in the State of New York, a soils scientist or geologist also licensed in the State of New York.

Initial Feasibility Testing

Feasibility testing is conducted to determine whether full-scale testing is necessary, and is meant to screen unsuitable sites, and reduce testing costs. A soil boring is not required at this stage. However, a designer or landowner may opt to engage Concept Design Borings per Table H-1 at his or her discretion, without feasibility testing.

Initial testing involves either one field test per facility, regardless of type or size, or previous testing data, such as the following:

* septic percolation testing on-site, within 200 feet of the proposed SMP location, and on the same contour [can establish initial rate, water table and/or depth to bedrock]
* previous written geotechnical reporting on the site location as prepared by a qualified geotechnical consultant
* NRCS County Soil Mapping *showing an unsuitable soil group* such as a hydrologic group "D" soil in a low-lying area, or a Marlboro Clay

If the results of initial feasibility testing as determined by a qualified professional show that an infiltration rate of greater than 0.5 inches per hour is probable, then the number of *concept design test* pits shall be per the following table. An encased soil boring may be substituted for a test pit, if desired.

Table D-1 Infiltration Testing Summary Table

Type of Facility	Initial Feasibility Testing	Concept Design Testing (initial testing yields a rate greater than 0.5"/hr)	Concept Design Testing (initial testing yields a rate lower than 0.5"/hr)
I-1 (trench)	1 field percolation test, test pit not required	1infiltration test and 1 test pit per 50' of trench	not acceptable practice
I-2 (basin)	1 field percolation test, test pit not required	1 infiltration test* and 1 test pit per 200 sf of basin area	not acceptable practice
F-1(sand filter)	1 field percolation test, test pit not required	1 infiltration test and 1 test pit per 200 sf of filter area (no underdrains required**)	underdrains required
F-6 (bioretention)	1 field percolation test, test pit not required	1 infiltration test and 1 test pit per 200 sf of filter area (no underdrains required**)	underdrains required

*feasibility test information already counts for one test location
** underdrain installation still strongly suggested

Documentation

Infiltration testing data shall be documented, which shall also include a description of the infiltration testing method, if completed. This is to ensure that the tester understands the procedure.

Test Pit/Boring Requirements

a. excavate a test pit or dig a standard soil boring to a minimum depth of 4 feet below the proposed facility bottom elevation

b. determine depth to groundwater table (if within 4 feet of proposed bottom) upon initial digging or drilling, and again 24 hours later

c. conduct Standard Penetration Testing (SPT) every 2' to a depth of 4 feet below the facility bottom

d. determine USDA or Unified Soil Classification System textures at the proposed bottom and 4 feet below the bottom of the SMP

e. determine depth to bedrock (if within 4 feet of proposed bottom)

f. The soil description should include all soil horizons.

g. The location of the test pit or boring shall correspond to the SMP location; test pit/soil boring stakes are to be left in the field for inspection purposes and shall be clearly labeled as such.

Infiltration Testing Requirements

a. Install casing (solid 4-6 inch diameter, 30" length) to 24" below proposed SMP bottom (see Figure D-1).

b. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate. Remove all loose material from the casing. Upon the tester's discretion, a two (2) inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill casing with *clean* water to a depth of 24" and allow to pre-soak for twenty-four hours

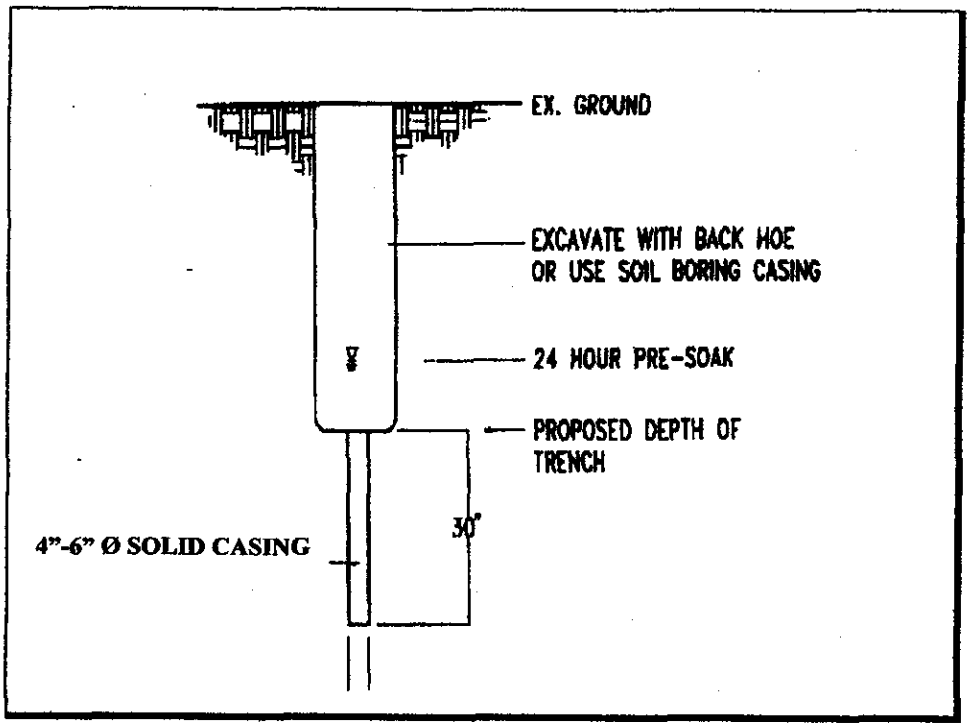
c. Twenty-four hours later, refill casing with another 24" of clean water and monitor water level (measured drop from the top of the casing) for 1 hour. Repeat this procedure (filling the casing each time) three additional times, for a total of four observations. Upon the tester's discretion, the final field rate may either be the average of the four observations, or the value of the last observation. The final rate shall be reported in *inches per hour.*

d. May be done though a boring or open excavation.

e. The location of the test shall correspond to the SMP location.

f. Upon completion of the testing, the casings shall be immediately pulled, and the test pit shall be back-filled.

Figure D.1 Infiltration Testing Requirements



Laboratory Testing

a. Grain-size sieve analysis and hydrometer tests where appropriate may be used to determine USDA soils classification and textural analysis. Visual field inspection by a qualified professional may also be used, provided it is documented. *The use of lab testing to establish infiltration rates is prohibited.*

Bioretention Testing

All areas to be used as bioretention facilities shall be back-filled with a suitable sandy loam planting media. The borrow source of this media, which may be the same or different location from the bioretention area itself, must be tested as follows:

If the borrow area is virgin, undisturbed soil, one test is required per 200 sf of borrow area; the test consists of "grab" samples at one foot depth intervals to the bottom of the borrow area. All samples at the testing location are then mixed, and the resulting sample is then lab-tested to meet the following criteria:

a) USDA minimum textural analysis requirements: A textural analysis is required from the site stockpiled topsoil. If topsoil is imported, then a texture analysis shall be performed for each location where the top soil was excavated.

Minimum requirements:

sand	35 - 60%
silt	30 - 55%
clay	10 - 25%

b) The soil shall be a uniform mix, free of stones, stumps, roots or other similar objects larger than two inches.

c) Consult the bioretention construction specifications (Appendix J) for further guidance on preparing the soil for a bioretention area.

Example Checklist for Preliminary/Concept Stormwater Management Plan Preparation and Review

- ☐ Applicant information
- ☐ Name, legal address, and telephone number
- ☐ Common address and legal description of site
- ☐ Vicinity map
- ☐ Existing and proposed mapping and plans (recommended scale of 1" = 50'.) which illustrate at a minimum:
  - ▸ Existing and proposed topography (minimum of 2-foot contours recommended)
  - ▸ Perennial and intermittent streams
  - ▸ Mapping of predominant soils from USDA soil surveys
  - ▸ Boundaries of existing predominant vegetation and proposed limits of clearing
  - ▸ Location and boundaries of resource protection areas such as wetlands, lakes, ponds, and other setbacks (e.g., stream buffers, drinking water well setbacks, septic setbacks)
  - ▸ Location of existing and proposed roads, buildings, and other structures
  - ▸ Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements
  - ▸ Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains
  - ▸ Flow paths
  - ▸ Location of floodplain/floodway limits and relationship of site to upstream and downstream properties and drainages
  - ▸ Preliminary location and dimensions of proposed channel modifications, such as bridge or culvert crossings
  - ▸ Preliminary location, size, and limits of disturbance of proposed stormwater treatment practices
- ☐ Hydrologic and hydraulic analysis including:
  - ▸ Existing condition analysis for runoff rates, volumes, and velocities presented showing methodologies used and supporting calculations
  - ▸ Proposed condition analysis for runoff rates, volumes, and velocities showing the methodologies used and supporting calculations
  - ▸ Preliminary analysis of potential downstream impact/effects of project, where necessary
  - ▸ Preliminary selection and rationale for structural stormwater management practices
  - ▸ Preliminary sizing calculations for stormwater treatment practices including contributing drainage area, storage, and outlet configuration
- ☐ Preliminary landscaping plans for stormwater treatment practices and any site reforestation or revegetation
- ☐ Preliminary erosion and sediment control plan that at a minimum meets the requirements outlined in local Erosion and Sediment Control guidelines
- ☐ Identification of preliminary waiver requests

Example Checklist for Final Stormwater Management Plan Preparation and Review

- ☐ Applicant information
  Name, legal address, and telephone number
- ☐ Common address and legal description of site
- ☐ Signature and stamp of registered engineer/surveyor and design/owner certification
- ☐ Vicinity map
- ☐ Existing and proposed mapping and plans (recommended scale of 1" = 50' or greater detail) which illustrate at a minimum:
  - ▸ Existing and proposed topography (minimum of 2-foot contours recommended)
  - ▸ Perennial and intermittent streams
  - ▸ Mapping of predominant soils from USDA soil surveys as well as location of any site-specific borehole investigations that may have been performed.
  - ▸ Boundaries of existing predominant vegetation and proposed limits of clearing
  - ▸ Location and boundaries of resource protection areas such as wetlands, lakes, ponds, and other setbacks (e.g., stream buffers, drinking water well setbacks, septic setbacks)
  - ▸ Location of existing and proposed roads, buildings, and other structures
  - ▸ Location of existing and proposed utilities (e.g., water, sewer, gas, electric) and easements
  - ▸ Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains
  - ▸ Flow paths
  - ▸ Location of floodplain/floodway limits and relationship of site to upstream and downstream properties and drainages
  - ▸ Location and dimensions of proposed channel modifications, such as bridge or culvert crossings
  - ▸ Location, size, maintenance access, and limits of disturbance of proposed structural stormwater Management practices
- ☐ Representative cross-section and profile drawings and details of structural stormwater Management practices and conveyances (i.e., storm drains, open channels, swales, etc.) which include:
  - ▸ Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.)
  - ▸ Design water surface elevations
  - ▸ Structural details of outlet structures, embankments, spillways, stilling basins, grade control structures, conveyance channels, etc.
  - ▸ Logs of borehole investigations that may have been performed along with supporting geotechnical report.

☐ Hydrologic and hydraulic analysis for all structural components of stormwater system (e.g., storm drains, open channels, swales, Management practices, etc.) for applicable design storms including: